MINISTRY OF
AGRICULTURE, FISHERIES AND FOOD

COSTS AND EFFICIENCY IN MILK PRODUCTION

1965-66

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FOREWORD

This report presents the results of the National Investigation into the Economics of Milk Production for the year ending March 1966. The investigation was based, for the first time in the history of the scheme, on a random sample of milk producing farms in England and Wales. The response from farmers was good and we are grateful to them for their excellent co-operation in providing all the information required for the investigation.

The last report in this series related to a two-year period ending in March 1962. Since then there have been changes in the prices received and paid by dairy farmers, and improvements in production techniques and management. It is hoped that this booklet will assist producers in their efforts to keep up-to-date in these changing times. A summary of the findings is given on pages 46–47.

The report has been produced for the Conference of Provincial Agricultural Economists by a special Working Party under the Chairmanship of Mr. S. R. Wragg of the University of Bristol, who is the author of Section III on 'Feeding the Dairy Herd'. The other members of the Working Party were the late Mr. J. A. Langley of the University of Exeter and Mr. A. J. Wynne of the University of Leeds, the author of Section IV on 'Labour in Milk Production', together with Messrs. R. E. Williams, G. J. Hickey and M. T. Jones of the Milk Marketing Board and Messrs. J. A. Evans and K. E. Gubbins of the Ministry. Mr. A. G. Antill of the University of Oxford and Dr. K. Cowling of the University of Manchester were also members of the Working Party in the initial stages of its work.

I also wish gratefully to acknowledge the part played by Mr. Harwood Long of the University of Leeds as Chairman of the Milk Costs Committee since 1959.

L. Napolitan
Chairman
Conference of Provincial Agricultural Economists

Ministry of Agriculture, Fisheries and Food
July 1967

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INTRODUCTION

The National Investigation into the Economics of Milk Production, which was first undertaken in 1934 and which is sponsored and financed jointly by the Milk Marketing Board of England and Wales and the Ministry of Agriculture, Fisheries and Food, is undertaken by the Provincial Agricultural Economists at ten universities in England and Wales.*

The Investigation alternates between periods of general research† and a survey period. Up to and including 1960–62,‡ the surveys were carried out over two years. But the results of the latest survey cover a period of one year from April 1965 to March 1966 and form the subject matter of this report. It is hoped that these results, and the commentary on them, will be a useful source for those who wish to become more informed about milk production, and to gain an insight into the productivity, cost structure and profitability of this very important branch of agriculture.

Three warnings need to be given at the outset. As will be shown in the first section, the farms in the study were selected randomly. This meant that the sample, within known margins of error, was typical of the full spectrum of dairy herds in the country. In previous studies farms with dairy herds were not selected at random and some caution is required in comparing the present costings with previous ones. This is more fully explained in the main text. On the other hand, the random nature of these costings will enable comparisons with future ones based on random samples to be of greater interest and more value.

Secondly, within dairying itself, there is a danger of seeing simple cause and effect relationships between inputs and profits which may not exist and which would not in any case necessarily be reproduced on every individual farm. The form of the tables unavoidably encourages this mistake, but it should be borne in mind that in these survey examples, unlike the controlled experiments of the physical scientists, inputs other than those being investigated will have varied, not least among them the important one of management.

Finally, the economics of milk production are bound up with the other enterprises carried out on the same farm. This study deals only with the milking herd, and the figures of total costs, net margin and family income depending as they do on the arbitrary allocation of certain costs between enterprises, should be interpreted with due caution.

From studies carried out by the Milk Marketing Board, and from analyses of the Ministry's agricultural censuses§ the changing structure of the dairy industry is well demonstrated. Between 1960 and 1965, the proportion of herds of under 20 cows has decreased from 60 to 44 per cent whilst the proportion of herds of over 50 cows has increased from 6 to 11 per cent. The smaller herds therefore tended to increase in size or go out of production. The information contained in the present report shows that the larger and higher yielding herds tended to be more profitable on average. However, herd size cannot always be increased without costly investment, nor high yields obtained without the possibly uneconomic use of concentrates. This report indicates some of the other factors which have an important bearing on the profitability of the dairy enterprise.

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*The addresses of Provincial Agricultural Economists are given in Appendix II

†A synopsis of the results of the research undertaken in 1962–1965 has been published in *Aspects of Dairy Economics*, H.M.S.O. 1967, price 5*s*. 6*d*.

‡A report on the 1960–62 survey period was published in *Costs and Efficiency in Milk Production*, H.M.S.O. 1964, price 4*s*. 0*d*.

§*The Structure of Dairy Farming in England and Wales during 1963/64*, Milk Marketing Board, Thames Ditton, Surrey, 1965. *The Structure of Agriculture*, H.M.S.O. 1966.

The survey, and the methods used to analyse its results, are thought to have added in some measure to existing knowledge about the economics of dairying. The sections describing the sample farms and the financial results provide useful background information for a wide variety of purposes. Those dealing with feeding and labour are designed to pick out the most important of the new information which has been obtained on those topics. But it is not the purpose of the report to provide either a manual of dairy management practices or a comprehensive handbook of management data. Publications serving these purposes are issued from time to time by the Ministry and by University Departments of Agricultural Economics.

I. THE FARMS IN THE SURVEY

Method of Sampling

One of the main new features of the present investigation, compared with those that have preceded it, is the introduction of random sampling. The object is to obtain a sample which reflects the national average in the costed year as closely as possible and to avoid bias in selection. In an industry in which structural change—which can affect cost levels—is taking place more rapidly than ever before, it has become even more important than in the past that all sections, the expanding and the contracting, the technologically advanced and those using more traditional methods, should be properly represented, in order that comparisons over time should have meaning. At the same time, the increasing cost-consciousness of dairy farmers has made it possible to employ this method of sampling, which depends on the willingness of farmers selected in this way to co-operate in the scheme. In the present investigation two out of three of the commercial milk producers in the sample selected took part in the investigation.

A technical appendix sets out in some detail the sampling procedures employed together with the methods of calculation of results. Very briefly, the sample was drawn by random selection from holdings with more than 5 dairy cows in the Agricultural Census returns, arranged in herd size groups. In the smallest size groups, with 6–9 cows, holdings were selected at the rate of 1 in 120 whilst in the largest group, with over 70 cows, at the rate of 1 in 18. Three samples of 495 were selected. The producers selected in the first sample were then contacted. Non-respondents were replaced by those selected in the same herd size groups from either the second or third samples.

Sampling Method used in Previous Investigations

In the past, non-random samples have been employed for the Milk Costs Investigations and the selection of the participating herds has been left to the individual Universities, each of which was responsible for supplying records for at least 40 herds. The sample as a whole was intended to include a selection of herds which represented the different sizes of herds and reflected the relative importance of dairying in different parts of the country.

Many of the herds surveyed under this arrangement were owned by producers who kept records as a matter of course and who had previously co-operated with the Universities, either in earlier Milk Costs Investigations or for other purposes. These herds might be expected to have been managed more efficiently than the general run of dairy herds, and this is suggested by the fact that the average herd size and yield per cow for the 1961/62 sample was 32 cows and 838 gallons respectively, compared with national averages in that year of approximately 24 cows and 780 gallons.

The effects of these two measures on costs and returns per cow and per gallon are critical, and an attempt was made to remove the bias in the results arising from the overestimation of herd size. Thus the results were adjusted to reflect the national distribution of dairy herd size groups, and the weighting reduced the overall averages to 24 cows and 830 gallons.

The failure of this adjustment for herd size to reduce the average yield to the national level, points to the difficulty of obtaining unbiased results from a non-random sample. This may be compared with the raised sample results of the present investigation, which closely reflect the national situation with an average herd size of 29 cows and yield of 809 gallons per cow.

The Magnitude and Nature of Non-Response

The sample was selected from holdings with more than 5 dairy cows, but some of these were not commercial milk producers and were thus ineligible for inclusion in the investigation. This category included cattle dealers, producers who gave up milk production between the time of the sample selection and the time the farm was first visited, and those who, at the time of the first farm visit, actually planned to leave milk production before or during the costing period. The further small number of producers who suddenly gave up milk production during the survey year have been classified as non-participants.

Of the total of 744 producers contacted, 88 were considered ineligible, 208 refused to participate and 14 failed to complete the survey, leaving a total sample of 434 co-operating producers. Thus, overall, 222 out of 656 or 34 per cent of the eligible producers contacted did not participate in the scheme.

Most of the 208 non-participants were either uninterested or reluctant to disclose financial information about their farm business, and the 14 who failed to complete the survey dropped out mainly through bad health or because they left milk production during the year.

The 34 per cent non-response shown by the sample as a whole conceals large variations between different parts of the country; this ranged from 8 per cent in the southern province to 60 per cent in the north-west. These were the two extremes, however, and apart from the Eastern province which also had an exceptionally low non-response rate, most others averaged about 1 out of 3 which may be regarded as generally satisfactory.

Virtually all those eligible producers who did not participate in the North-West withdrew before the start of the survey period due to lack of interest, financial and other reasons, and only one started and failed to complete the

TABLE 1

Non-Response Rate by P.A.E.S. Province

	Province										
	Northern	North-eastern	North-western	East-midland	South-western	Western	Southern	Eastern	South-eastern	Wales	Total
Total Number of producers contacted	47	74	149	52	108	115	29	27	42	101	744
Non-eligibles	4	18	12	5	14	16	3	1	4	11	88
Eligibles	43	56	137	47	94	99	26	26	38	90	656
Non-participants	13	20	82	11	36	22	2	3	13	20	222
Participants	30	36	55	36	58	77	24	23	25	70	434
Non-participants as % of eligibles	30	36	60	23	38	22	8	11	34	22	34

Of the final sample of 434 co-operating producers, 285, or 66 per cent, were from the initial sample, and 114 and 35 were drawn as replacements from the second and third samples respectively.

survey. This province had the highest number of herds in the selected sample but, due to the high rate of non-response, only the third highest number in the final sample.

Table 1 shows the different non-response rate in the 10 provinces of the Provincial Agricultural Economics Service and in England and Wales as a whole.

Sample Performance and Structural Features

One of the benefits of random sampling, apart from the increase in accuracy of the data themselves, is that the results can be used to describe a number of structural features of the dairy industry in England and Wales not available elsewhere. In certain cases where national data are available, the raised results also form a check on the overall performance of the sample. Furthermore, the improved accuracy makes it possible to quote the results for the first time in 'aggregate' form.

Comparison of Raised Figures with National Totals

The first check on the performance of the sample can be made by comparing the raised total sales with the actual sales through the M.M.B. in 1965/66. This has been done in Table 2 and it can be seen that agreement over the year as a whole and in most months was fairly close. The raised sample overstated sales for the year as a whole by some 4 per cent. Table 2 shows that the earlier months of the survey year tended to be slightly more accurate than the later months, which were further removed from the time when the sample was drawn and the raising factors calculated. For a small sample an error of 4 per cent on a sensitive indicator such as sales might be judged a good result. There are a variety of reasons why exact correspondence between the

TABLE 2

Actual Sales of Milk Off Farms in Comparison with the Raised Sample Results for England and Wales

1965/66	Actual sales	Raised sample results	Difference	
				%
	million gallons			
April	183·0	186·0	+3·0	+1·6
May	212·6	217·2	+4·6	+2·2
June	195·9	201·7	+5·8	+3·0
July	182·0	188·1	+6·1	+3·4
August	173·0	181·1	+8·1	+4·7
September	163·4	172·6	+9·2	+5·6
October	168·4	176·7	+8·3	+4·9
November	158·3	166·3	+8·0	+5·1
December	157·0	164·0	+7·0	+4·5
January	157·2	164·3	+7·1	+4·5
February	146·1	154·2	+8·1	+5·5
March	171·6	181·4	+9·8	+5·7
April/March	2,068·5	2,153·6	+85·1	+4·1

raised sample and actual sales would not be expected—the sample excluded those with less than 6 cows, it does not reflect producers leaving during the year, and the population on which the raising factors are calculated included some producers not eligible for participation. An exhaustive list or an assessment of these factors is impossible. However, the consistent monthly overstatement does suggest a slight bias towards overstatement of average herd size and milk sales.

The performance of the raised sample can also be tested by reference to cow numbers. This has been done in Table 3 in the herd size groups equivalent to those used for the sample selection. Again, the raised sample tended to slightly overstate cow numbers in each group, and the total dairy herd was overstated by about 6 per cent. Since the raising factors were calculated on the number of producers in each group, the overstatement of cow numbers arose because the average herd size within groups was slightly overstated. It may be judged that any bias introduced into the results by this is likely to be small, since the June Agricultural Census figures tend in any case to be seasonally low (by possibly 1–2 per cent) and the raised sample figures were an average for the year.

TABLE 3

Distribution of Dairy Herds and Cows by Herd Size Groups and Comparison with Raised Sample Results

Herd size (cows)	England & Wales*				Raised sample cows ('000)	Difference in cows	
	Herds		Cows				
	'000	%	'000	%		'000	%
6–9	10·7	11	78	3	89	+ 11	+14·1
10–19	31·7	33	463	18	494	+ 31	+ 6·7
20–29	23·0	24	529	20	572	+ 43	+ 8·1
30–49	20·0	21	738	28	776	+ 38	+ 5·1
50–69	6·7	7	389	15	392	+ 3	+ 0·8
70 and over	4·2	4	405	16	430	+ 25	+ 6·2
Total	96·3	100	2,602	100	2,753	+151	+ 5·8

*Agricultural Census June 1965

Apart from testing the sample cow numbers, Table 3 includes the data of herds by size groups and these are not without an interest of their own. A dairy herd with more than 30 cows in June 1965 was more the exception than the rule as only about 3 out of 10 herds fell into the three groups with more than this number; herds of more than 50 cows were only 11 per cent of the total. Of the total number of cows, however, over half were in herds of over 30 cows and nearly one-third were in herds of over 50 cows. The dairy industry, therefore, is characterized by a large number of small producers but a high proportion of production comes from a growing but relatively small group at the top end of the scale.

One further test of the sample can be made by comparing the breed position of the *herds* with other data. This has been done in Table 5 which compares the survey sample with the raised results of an M.M.B. sample in

1963/64. In this Table herds in both samples are classified under a particular breed if more than 80 per cent of their cows are of that breed. Producer numbers declined between 1963/64 and 1965/66 and the M.M.B. results relate to all producers. Nevertheless, there is close agreement in the breed structure between the two sources with a slightly higher proportion of Friesian herds in the 1965/66 sample, but this is in accordance with the known national trend.

TABLE 4

Comparison of Herd Numbers According to the Predominant Breed of the Herd

Breed	England & Wales(1)		Raised sample	
	'000	%	'000	%
Ayrshire	8·6	8·3	7·8	8·1
Friesian	50·6	48·9	50·1	52·0
Guernsey	5·4	5·2	4·7	4·9
Jersey	2·7	2·6	3·2	3·3
Shorthorn	4·8	4·6	1·7	1·8
Red Poll	0·5	0·5	0·2	0·2
South Devon	0·9	0·9	0·7	0·7
Other(2)	30·1	29·0	27·9	29·0
Total	103·6	100·0	96·3	100·0

Notes: (1) *The Structure of Dairy Farming in England and Wales during* 1963/64, M.M.B. 1965.
(2) This includes Cross Bred and Mixed herds.

Structural Features of Milk-Producing Farms

The average size of farm in the raised sample was 115 acres, including rough grazing adjusted to a permanent grass equivalent. Six out of every 10 farms, however, were below 100 acres, leaving just over 3 in 10 between 100 and 300 acres and less than 1 in 10 over 300 acres.

The average farm had approximately two-thirds of its adjusted total acreage under grass (about 25 per cent ley and 40 per cent permanent grass) and the other third was devoted to crops. The variation in these proportions between small and large farms was considerable: the crop acreage varied from 1 per cent on the smallest farms to 50 per cent on the largest, so a much higher proportion of the smaller farms was under grass.

Nearly 50 per cent of the total acreage of crops and grass on the average farm was devoted to the dairy cows, and this varied from just under 90 per cent for the smallest farms to just over 30 per cent for the largest. This supports evidence from other surveys of the much heavier dependence of the small milk-producing farms on that product for their income.

Rent in the calculation of cost is taken as the actual payment on rented farms, or the imputed rental value on owner-occupied farms, expressed per acre and applied to the acreage occupied by the dairy herd. The average level of gross rent per adjusted total acre of the farm is given in Table 5. For the whole sample it amounted to £4 9*s*. per acre. The higher average rents per acre on the smaller farms compared with the average are largely explained by the greater influence of the residential element in the rents of such farms. The level of average rent per acre is fairly constant for all size groups and, though calculated on a slightly different basis, is higher than the average for all farm land shown by the Agricultural Land Service Rent Enquiry. This is a reflection of the relatively good quality of the land generally occupied by dairying and of the amount of fixed capital invested in dairy buildings.

TABLE 5

Land Use and Size Distribution of Sample Farms in 1965/66

Item	Farm Size (adjusted acres)							
	Less than 25	25–49	50–99	100–149	150–199	200–299	300 & over	All Herds
Raised sample (per cent of herds)	5·7	15·5	39·9	15·3	10·5	7·7	5·4	100·0
Farm size (adjusted acres)	17	37	71	120	172	233	483	115
Herd size (cows)	9·2	15·8	21·7	31·6	36·0	55·6	75·1	28·6
Yield (gal per cow)	751	768	794	801	845	820	835	809
Rent (£ per adjusted acre)	6·4	5·1	4·8	4·6	4·9	4·9	5·3	4·9
	per cent of adjusted total acres							
Arable	1·2	7·6	16·9	20·6	28·5	35·3	50·2	29·2
Ley	9·8	30·5	29·5	24·7	27·6	26·2	20·8	25·8
Permanent grass	81·6	57·0	49·8	50·8	40·4	35·1	24·7	41·1
Adjusted rough grazing	5·7	3·3	2·1	2·3	1·8	1·4	2·9	2·3
Roads, buildings, etc.	1·7	1·6	1·7	1·6	1·7	2·0	1·4	1·6
Adjusted total acres	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0
	acres per cow in milking herd							
Forage acres	1·6	1·6	1·8	1·9	1·9	1·7	1·8	1·8
Livestock acres	1·6	1·6	1·9	2·0	2·1	1·8	2·0	1·9
Adjusted feed acres	2·8	2·7	2·7	2·8	2·9	2·6	2·7	2·7

Three measures of stocking rate and the use of land for the dairy herd are presented in Table 5.

Forage acres per cow refer to the acreage of grass and fodder crops used for the dairy herd. *Livestock acres per cow* includes the acreage equivalent of home-grown concentrates used by the dairy herd. *Adjusted feed acres per cow* takes into account also the acreage equivalent of bought-in feeds.

The three measures together illustrate some interesting differences between the production methods on small and large farms. Adjusted feed acres per cow showed very little difference between small and large farms, whilst livestock acres per cow were greater on larger farms. Forage acres also increased with farm size at least up to farm sizes of 100–149 acres. These differences reflect the fact that the larger farms were much less dependent on bought-in feeding stuffs than smaller farms, although feeding levels overall did not vary greatly between small and large farms.

An interesting feature of Table 5 is that the average level of yield has a tendency to be higher on larger farms with their larger herds, although this may be associated with factors other than size. The overall average yield was 809 gallons per cow which compares with the M.M.B. calculation for 1965/66 of 800 gallons per cow*. Nevertheless, on farms of over 150 acres the average was well exceeded whilst on farms below 100 acres yield fell below average.

The sample also gives some details of the dairy buildings and equipment on the farms. Nearly 16 per cent of herds (and 28 per cent of cows) were milked in parlour systems, whilst 76 per cent of herds (65 per cent of cows) were machine-milked in traditional cowsheds. Average herd size, therefore, of those producers with parlour systems was more than twice that of those with traditional cowsheds. Hand-milking only took place on a very small percentage of farms.

TABLE 6

Place of Milking—Estimated Distribution in England and Wales 1965/66

Place and method of milking	Raised No. of herds		Raised No. of cows		Average herd size
	No.	%	'000	%	(cows)
Parlour (machine)	15,250	15·8	782	28·4	51·3
Cowshed (machine)	73,560	76·4	1,788	65·0	24·3
Hand-milking, bail, etc.	7,490	7·8	183	6·6	24·4
Total	96,300	100·0	2,753	100·0	28·6

Finally, a rough estimate can be made of the capital invested in the form of live stock and dairy equipment. In Table 7, on page 10, the livestock valuation was taken as the average of the opening and closing values in the herd stock account. The valuation of dairy equipment was the average of the opening and closing inventories plus an appropriate proportion of farm equipment used substantially for dairying or preparing food for the herd.

On average, £85 was invested per cow, £78 in the cow and £7 in its associated dairy equipment. There was a general tendency for cow values to be higher on larger farms, at least up to 200 acres, and this may indicate that the larger herds have slightly better quality cows than the smaller herds and may reflect the differences in yield noted earlier. The average value of £78 per cow in herd may be compared with the average value of incoming cows and heifers at £90 and of cow disposals at £58. Dairy equipment values varied only to a minor degree amongst the smaller farm size groups (except for a relatively high value for the farms under 25 acres) but were significantly

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*Dairy Facts and Figures 1966, p. 30.

TABLE 7

Capital Invested in Dairy Cows and Equipment by Farm Size Group 1965/66

	Farm size (acres)							
	Less than 25	25–49	50–99	100–149	150–199	200–299	300 & over	All herds
Capital per cow in:								
Dairy cows	70	73	77	78	82	78	79	78
Dairy equipment	8	6	6	7	7	9	10	7
Total	78	79	83	85	89	87	89	85
Capital in dairy cows and equipment per herd	720	1,250	1,810	2,680	3,190	4,840	6,690	2,440

higher for the two largest groups, probably reflecting a change-over to more sophisticated systems for handling and milking cows in the largest herds.

The average amount of capital in livestock and dairy equipment amounted to £2,440. However, this is only a part of the capital necessary for the running of the dairy enterprise. It takes no account of the machinery required for grass conservation and maintenance, fodder crop and cereal production, or of working capital necessary for the purchase of lahour, materials and services. A more appropriate figure might be of the order of £150 per cow for all tenant capital which would suggest an average tenant capital for the dairy enterprise of over £4,000.

Aggregate Costs, Returns and Margins

Aggregate costs, returns and margins data are of interest insofar as they enable the dairy industry to be placed in perspective in relation to the agricultural industry as a whole. Table 8 shows the costs in aggregate form. The net margin of milk production in England and Wales in 1965/66 amounted to nearly £80 million. If the value of the unpaid labour of farmer and wife of £37·3 million is added this gives the equivalent of a 'net farm income' of £117·2 million. It is interesting to note that the 'Departmental' calculation estimates the aggregate farming net income in the U.K. for 1965/66 as £468½ million*. Although there are differences in method of calculation it can be said, as a broad order of magnitude, that milk production in England and Wales was thus responsible for about one-quarter of the U.K. farming net income in 1965/66.

Table 9 shows wide differences in the distribution of aggregate costs, returns and margins by herd size groups. The table shows that large herds, because of their lower costs, earn an even greater proportion of the aggregate net margin than of total returns. Thus, the 11 per cent of herds of over 50 cows account for just over 30 per cent of total return but 42 per cent of the industry's net margin. Herds of below 20 cows receive nearly 20 per cent

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*Cmnd. 3229.

TABLE 8

Aggregate Costs, Returns and Margins in Milk Production in England and Wales 1965/66

Costs		£m.	%	Returns	£m.	%
Feeds:	Purchased	91·0	29·8	Milk sales (2,226·4 m.g.)	357·0	92·8
	Home grown	39·2	12·9			
	Grazing	27·0	8·9			
	Total	157·2	51·6			
Labour:	Paid	25·9	8·5	Calf sales (2,570 '000 head)	27·8	7·2
	Farmer & wife	37·3	12·2			
	Other family labour	7·1	2·3			
	Total	70·3	23·0			
Miscellaneous		59·0	19·4			
Herd replacement		18·4	6·0			
Gross cost		304·9	100·0			
Net margin		79·9	—			
Total		384·8	—	Total	384·8	100·0

of the industry's total return but only 6½ per cent of the net margin. This further emphasizes the structural characteristics of the industry portrayed earlier. A further interesting feature of Table 9 is the rather more even distribution of family income (net margin plus the imputed cost of family labour) than of net margins. The addition of family labour to herds with less than 20 cows lifts their income from 6½ per cent of the total net margin to nearly 20 per cent of total family income; at the same time, it reduces the share of those with more than 50 cows from 42 per cent to just under 30 per cent. The return offered to family labour enables dairy farming to survive in small herds.

TABLE 9

Aggregate Number of Herds, Costs, Returns and Margins by Herd Size Groups (Percentage Distribution)

Herd size (cows)	Number of herds (%)	Total costs (%)	Total returns (%)	Family income (%)	Net margin (%)
6–9	11·1	3·7	2·8	2·8	–0·8
10–19	33·0	19·3	16·8	16·7	7·4
20–29	23·8	20·8	20·5	22·1	19·3
30–49	20·7	27·6	28·6	28·9	32·1
50–69	7·0	14·0	14·8	13·5	17·9
70 and over	4·4	14·6	16·5	16·0	24·1
Total	100·0	100·0	100·0	100·0	100·0

II. MILK PRODUCTION COSTS AND RETURNS

Accounting Methods

To enable all the herds in the investigation to be costed on a comparable footing and to give clarity to the meaning of costs, returns and margins, standard accounting methods and definitions were used throughout. It is important that these should be understood before the results are studied or comparison made with farms costed in a different way.

The dairy herd, which was the unit for costing purposes, consisted of cows in milk and dry cows. Permanent nurse cows and followers were excluded. Home-grown feeds were charged at costs of production. For forage crops, home-grown cereals and ley establishment standard costs per acre were used. These were adjusted for individual farms according to actual rent charged and converted to costs per cwt by reference to actual yields on the farm. Grazing costs other than those of ley establishment were actual costs on individual farms. An alternative method of charging home grown foods is to value them at market prices and the effects of doing this are discussed on pages 15 and 19. Hours of labour spent with the dairy herds were recorded and hired labour was charged at cost to the farmer. The farmer's own manual labour was charged at average hourly earnings for skilled stockmen and other unpaid labour at appropriate average rates. Various miscellaneous expenses were included, such as repairs, renewals of equipment and veterinary expenses. A.I. service fees, if not actually incurred, were imputed at average rates and all costs relating to bulls kept were ignored. To the direct expenses of the milking herd were added the costs of herd replacement and depreciation, the details of which are given on page 44.

In calculating returns, milk sold wholesale or fed to livestock was valued at wholesale prices, net of M.M.B. transport deduction. Milk sold at retail was valued at a standard price of 44·17*d.* per gallon reflecting average net returns to producer-retailers. Milk sold to employees or used in the farmhouse was valued at the maximum rates prescribed by the Agricultural Wages Orders. The returns from calves produced, at actual or imputed sale price at four days old, were added to the returns from milk to arrive at total returns.

Net margin is the difference between total returns and costs of milk production including an estimate of the value of manual work of the farmer and his family. Net margin therefore represents the reward for the farmer's managerial skill and the use of the capital invested in milk production and is the same as *management and investment income.* A number of tables show family incomes derived from dairying. *Family income* is the net margin plus the charge made for the manual work of the farmer and unpaid members of the family.

The Interpretation and Use of the Results

The tables in this section of the book describe the physical inputs and outputs and the financial results of the herds in the sample as a whole, and of various size-groups of herds within the sample. The figures given for each size-group are reliable indicators of the average characterisitcs and results of all herds of that size in England and Wales. As such they provide background and comparative data which may be of use to farmers when assessing the profitability of their herds or when considering changes in policy. But care is needed in using these figures for planning purposes. It is important to remember, first, that they are averages only and, secondly, that they relate to groups of herds which have only one characteristic in common, that is the number of cows in them; the herds in any size-group may differ markedly from each other in many other respects, for instance in breed, feeding practice or location of milking. If therefore, a farmer were considering increasing the size of his herd he would be wrong to assume that his results would necessarily be altered from the averages shown in the tables for his present size-group to those shown for the group into which he might move his herd. The interpretation of the data is discussed further in a later section (page 22).

Costs, Returns and Margins in 1965/66

A summary of the costs, returns, net margin and family income for the 434 herds in the sample for 1965/66 is shown in Table 10.

The importance of feed and labour costs in relation to total costs of £110. 15*s*. per cow is clearly demonstrated, with feed accounting for over 50 per cent and labour 23 per cent of total costs. Further analysis of the feed costs shows that over half consisted of bought feeds. On the labour side, over 60 per cent of the labour costs was accounted for by the farmer and wife and other unpaid labour. Total returns, at nearly £140 per cow, made up of £10 from the sale of calves and nearly £130 from milk, gave a net margin of £29 per cow or 21 per cent of total returns. With all unpaid labour added to net margin, family income came to just over £45 per cow or 32 per cent of total returns.

Comparison with Costs, Returns and Margins in 1961/62

The results are interesting, not only as a description of the present structure of costs and returns, but also for the comparison they provide with results in previous years. A survey was last made in 1961/62 and in order to make the two sets of data comparable, the 1961/62 results shown in Table 10 were adjusted to reflect the distribution of the national herd at that time. However, there still remain some differences. In the first place, the 1961/62 survey was based on a non-random sample (see page 2). Secondly, there are some differences in method between the two surveys, which cannot be removed: but these should not affect the results to any great extent. Despite these reservations, a broad comparison in terms of costs and returns is at least reasonably fair and of considerable interest.

The increase in the cost of milk between the two costings was 3½*d*. per gallon or almost 12 per cent of which just over a penny was due to feed, another 1*d*. to labour and just over a 1*d*. to miscellaneous expenses. The breakdown of the feed costs shows that the increased expenditure was confined to purchased feeds. The increase in labour costs came about because an appreciable reduction in the number of hours per cow from 99 to 88 did not offset fully the increase in the unit cost of labour between the two periods. Unpaid labour in 1965/66 contributed 63 per cent to the total labour cost compared with 55 per cent in 1961/62. The cost of herd replacement showed little change between the two costings.

TABLE 10

Costs, Returns and Margins for a Sample of Dairy Herds in 1965/66 *Compared with a Sample in* 1961/62

	1961/62	1965/66	Difference	1961/62	1965/66	Difference
No. of herds	509	434	−75	—	—	
Av. No. of cows per herd	23·9	28·6	+4·7	—	—	
Av. yield per cow (gal)	830	809	−21	—	—	
Labour hours per cow	99	88	−11	—	—	
Livestock acre per cow	1·95	1·92	− 0·03	—	—	
	£ per Cow			*d.* per Gallon		
Costs						
Feeds: purchased	29·05	33·05	+4·00	8·4	9·8	+1·4
home-grown	15·45	14·25	−1·20	4·5	4·2	−0·3
grazing	10·05	9·80	−0·25	2·9	2·9	
TOTAL	54·55	57·10	+2·55	15·8	16·9	+1·1
Lahour: paid	9·85	9·40	−0·45	2·9	2·8	−0·1
unpaid	12·70	16·15	+3·45	3·6	4·8	+1·2
Total	22·55	25·55	+3·00	6·5	7·6	+1·1
Miscellaneous	17·80	21·45	+3·65	5·1	6·4	+1·3
Herd replacement	6·55	6·65	+0·10	1·9	2·0	+0·1
TOTAL COSTS	101·45	110·75	+9·30	29·3	32·9	+3·6
Returns						
Milk	118·85	129·70	+10·85	34·4	38·5	+4·1
Calves	6·30	10·10	+3·80	1·8	3·0	+1·2
TOTAL RETURNS	125·15	139·80	+14·65	36·2	41·5	+5·3
Net margin	23·70	29·05	+5·35	6·9	8·6	+1·7
Family income	36·00	45·20	+9·20	10·5	13·4	+2·9
	per livestock acre					
Total costs	52·15	57·65	+5·50	—	—	
Total returns	64·30	72·80	+8·50	—	—	
Net margin	12·15	15·15	+3·00	—	—	
Family income	18·45	23·55	+5·10	—	—	

The increase in total costs however was more than offset by the increase in returns which went up by the equivalent of 5¼*d.* per gallon. The average realization price for milk went up by just over 4*d.* per gallon, whilst the increased return from calves, reflecting the increased demand for calves for beef, was equivalent to just over 1*d.* per gallon. Calf prices, however, fluctuate from year to year so that this increase in returns due to calf prices could diminish or disappear or could continue further in particular years, depending on market conditions. The net margin therefore rose by 1¾*d.* to just over 8½*d.* per gallon whilst the family income rose by 3*d.* to almost 1*s.* 1½*d.* It is impossible to say how much these changes in costs and returns are affected by the biased nature of the 1961/62 sample but it is probable that the sample over-estimated the profitability of milk production in that year. Therefore, if anything, the increase in margins shown by the figures is understating the magnitude of the improvement.

Effect of Charging Home-Grown Cereals at Market Prices

It has been stated that home-grown concentrates are charged in the investigation at cost of production. This means that the profit from growing crops for feeding is included in the results of the dairy enterprise. If, on the other hand, these feeds were charged at market prices, thus showing the results of dairying in isolation, feed costs and total costs would be higher and net margin and family income lower. The amount of this difference has been estimated by comparing costs of production of home-grown cereals with average market prices during the year of the survey. Table 11 shows the differences in costs and margin between the two methods. The increase in cost and therefore decrease in margins was £1 17*s.* per cow or just over ½*d.* per gallon. This represents a 3 per cent increase in total feed costs, 1½ per cent in total cost or a 6½ per cent decrease in net margin. These percentage changes only refer to the sample as a whole. They vary among particular groups, e.g., small or large herds, because of differences in the proportion of home-grown cereals fed. The effect of the method of valuation on costs and margins in each herd-size group is shown on page 20.

TABLE 11

Comparison of Costs and Margins when Home-grown Cereals are Valued at Costs of Production and at Market Price

	Home-grown cereals at cost of production	Home-grown cereals at market price	Home-grown cereals at cost of production	Home-grown cereals at market price
	£ per cow		*d.* per gallon	
Feeds—home-grown	14·25	16·10	4·2	4·8
Total feeds	57·10	58·95	16·9	17·5
Total costs	110·75	112·60	32·9	33·4
Total returns	139·80	139·80	41·5	41·5
Net margin	29·05	27·20	8·6	8·1
Family income	45·20	43·35	13·4	12·9

Physical Inputs and Outputs

Feed

This was the most important item in the cost of producing milk and can best be classified into concentrate and bulk feeds. Table 12 shows that for the whole sample 22·8 cwt of concentrates were fed per cow or 3·2 lb on average per gallon of milk. Of these concentrates, 84 per cent were bought and the remaining 16 per cent home-grown. Of the bulk feeds, hay, kale and silage were the predominant ones used to provide winter maintenance and some part of production. The relative weights of these various bulk feeds do not of course indicate their contribution in terms of dry matter, starch equivalent or protein because of vast differences in feeding value; feeding values are, however, to some extent reflected in costs per cwt. But simple price relativities do not by themselves indicate the most economic way of feeding the dairy herd for maximum profit.

One of the critical factors in the management and economics of the enterprise is the use of land for feeding cows. The Investigation showed that each cow required an average of 1·8 forage acres, of which just over 1·7 acres was grass. The addition of the home-grown concentrate acreage leads to an average of 1·9 livestock acres, whilst the acreage equivalent of purchased feeds was estimated to be 0·8 extra acres per cow. The relationship between these and other factors affecting profitability is discussed more fully in Section III.

TABLE 12

Physical Inputs and Outputs in Producing Milk 1965/66

	per cow	per gallon	Average cost per cwt.	
Inputs	cwt	lb	*s.*	*d.*
Feed: Concentrates				
purchased compounds	14·8	2·1	34	7
purchased straights	4·3	0·6	26	10
home-grown	3·7	0·5	11	7*
Total	22·8	3·2	29	5
Hay purchased	1·5	0·2	10	9
home-grown	21·0	2·9	6	9
Straw	1·1	0·2	2	5
Roots and green fodder	5·8	0·8	2	2
Kale	18·2	2·5	1	5
Silage	26·6	3·6	2	0
Other feeds	4·7	0·7	3	2
	acres			
Acres Forage acres†	1·8			
Livestock acres‡	1·9			
Adjusted Feed acres§	2·7			
	hours			
Labour: Paid	33			
Unpaid—Farmer and wife	45			
Other	10			
Total	88			
Outputs	gallons			
Milk—Average yield per cow	809			
	numbers			
Calves born per cow	0·93			
of which: died	0·06			
sold	0·40			
retained for rearing	0·47			

*Market price of home-grown concentrates was 21*s.* 6*d.* cwt.

†Forage acres consists of all acres of grass and other forage crops.

‡Livestock acres consist of forage acres plus an acreage equivalent of home-grown concentrates.

§Adjusted feed acres consist of livestock acres plus an acreage equivalent of all bought feeds.

Labour

This is the second most important item of cost in producing milk. For the sample as a whole 88 hours of labour per cow were used, of which 33 hours (38 per cent of total labour) were paid and the remaining 55 hours (62 per cent) were provided by unpaid family labour most of which was farmer and wife labour. Details were obtained of the amount of labour used in milking alone by recording the typical milking routine in the sample herds in March 1966, this month being thought to be fairly representative of the year as a whole. On the assumption that this is so, it is estimated that 53 hours per cow over the year were spent on milking and 35 hours on other herd operations. Over the whole sample, 1·7 workers per herd were required for milking and on average they milked 14·3 cows each at a rate of 11·4 cows per hour. Within these averages there are of course wide differences according to herd size, place of milking and method of milking. A more detailed analysis of labour usage can be found in Section IV.

Outputs

Milk is the main output item and is discussed in detail under the various factors which influence yield (Section III). The other output item is calves which, although in terms of output is of considerably less importance than milk, has a part to play in the profitability of the dairy herd. In 1965/66, the calving percentage was 93 per cent; of the calves born, 43 per cent were sold, over 50 per cent were retained for rearing and the remainder died.

Relative importance of Inputs

The importance of total feed costs and labour costs has already been mentioned: in Table 10 they accounted for three quarters of the total cost per cow. In that Table inputs are classified according to the form in which they entered into milk production. A different classification may be applied which shows the inputs in the form in which they were originally incurred as farm expenses. Thus, for example, costs attributed to home-grown barley consisted originally of fertilizers, labour, machinery fuel and repairs and so forth. The structure of total costs in terms of these 'primary' inputs was as follows:—

Primary Cost Structure of Milk Production
1965/66

	per cent
Manual labour	34·2
Contract services	0·8
Rent	9·4
Purchased fertilizers	5·4
Purchased feeds	30·5
Seeds	0·9
Machinery depreciation and repairs	5·9
Fuel and oil	1·9
Miscellaneous	11·0
Total	100·0

Costs, Returns and Margins for Herds of Different Sizes

The description of the results of the investigation in this section has until now been in terms of averages for all herds. But there is a wide variation of results between individual farms. These variations stem from many factors among which are breed of cow, feeding practice, geographical distribution, standard of management and size of herd. In past investigations the analysis of the results by this last factor, herd size, has shown up some important differences in the structure of costs and returns according to the scale of operations. This analysis has been repeated for this investigation and is shown in Table 13.

TABLE 13

Costs, Returns and Margins by Herd Size Group

Herd Size (cows)	6·0–9·9	10·0–19·9	20·0–29·9	30·0–39·9	40·0–49·9	50·0–59·9	60·0–69·9	70·0–99·9	100 & over	All Herds
Number of Herds	17	92	81	70	51	41	23	38	21	434
Av. size of herd	8·3	15·6	24·9	34·8	44·4	54·9	64·6	82·2	138·6	28·6
Av. yield per cow (gal)	684	762	802	828	812	840	837	850	848	809
Seasonality (winter gal as per cent of year)	41·3	43·8	46·6	47·1	47·7	47·3	50·0	49·5	48·6	46·9
Labour hours per cow of which	162	118	94	87	72	72	65	61	62	88
percentage unpaid labour	98	88	77	62	50	36	17	13	–	62
	£ per cow									
Feeds—Purchased	33·80	34·75	34·60	35·40	33·05	33·30	31·45	29·30	24·85	33·05
home-grown	11·85	14·45	12·90	14·15	14·25	14·75	16·25	15·50	15·30	14·25
grazing	8·25	8·90	9·10	9·50	9·85	11·10	11·15	10·00	12·15	9·80
total	53·90	58·10	56·60	59·05	57·15	59·15	58·85	54·80	52·30	57·10
Labour—paid	0·35	3·75	5·55	8·75	10·15	13·40	15·95	16·60	19·95	9·40
unpaid	46·70	30·15	20·95	16·10	10·60	7·80	3·50	2·45	0·15	16·15
Total	47·05	33·90	26·50	24·85	20·75	21·20	19·45	19·05	20·10	25·55
Miscellaneous	22·25	21·20	20·40	21·95	20·65	21·50	23·00	22·40	22·85	21·45
Herd replacement	4·30	5·85	7·30	6·90	5·40	7·00	8·10	6·80	8·25	6·65
Total costs	127·50	119·05	110·80	112·75	103·95	108·85	109·40	103·05	105·50	110·75
Returns—milk	108·65	120·30	127·45	131·20	131·00	136·15	137·40	138·35	139·50	129·70
value of calves	11·70	10·70	10·35	10·90	9·95	9·05	8·95	9·40	8·50	10·10
Total returns	120·35	131·00	137·80	142·10	140·95	145·20	146·35	147·75	148·00	139·80
Family income	39·60	42·05	47·90	45·50	47·60	44·15	40·45	47·15	44·70	45·20
Net margin	−7·10	11·90	26·95	29·40	37·00	36·35	36·95	44·65	44·55	29·05
	pence per gallon									
Total costs	44·7	37·5	33·2	32·7	30·7	31·1	31·4	29·1	29·3	32·9
Total returns	42·2	41·3	41·3	41·2	41·7	41·5	42·0	41·7	41·9	41·5
Family income	13·9	13·3	14·3	13·2	14·1	12·6	11·6	13·3	12·7	13·4
Net margin	−2·5	3·8	8·1	8·5	11·0	10·4	10·6	12·6	12·6	8·6
	Standard Errors									
Labour requirements (hours per cow)	±11	±4	±3	±3	±3	±3	±4	±3	±5	±1
Total feed costs (£ per cow)	±4·69	±1·74	±1·70	±1·64	±2·24	±2·11	±3·08	±1·67	±2·79	±0·72
Net margin (£ per cow)	±7·17	±2·33	±2·52	±2·52	±2·72	±3·20	±5·59	±2·53	±5·21	±1·06

On the output side average returns per cow from milk were markedly higher in the larger herds than in the small and medium-sized herds, and were particularly low in herds with fewer than 20 cows. These differences were accounted for mainly by the pattern of yields per cow and partly by differences in the average return per gallon from milk. Yields per cow were fairly close to the average for the whole sample in the herds between 20 and 50 cows, well below average in the smaller herds and 30 to 40 gallons better in the herds of 50 or more cows. The average return per gallon from milk is mainly affected by the seasonality of production, since higher prices are obtained in the winter months, and by the quality premiums attained. Seasonality varied from 41 per cent winter milk production in the smallest herd-size group to about 50 per cent in the largest size group. As returns per gallon from milk showed far less variation in comparison, it would appear that milk quality and other factors offset some of the price advantages gained by larger herds from their greater emphasis on winter milk. The contribution to total return per cow made by the value of calves was rather bigger in the smaller than in the larger herds but the many factors affecting these values cannot readily be discerned from the information available. Despite this offset in favour of the smaller herds, the pattern of total returns per cow followed that of returns from milk.

On the input side, total costs per gallon and per cow tended to be higher in the smaller herds than in the larger herds. The input item which makes the biggest contribution to cost reduction in larger herds is labour. The total requirements per cow varied from 162 hours per cow in the smallest size group to 62 hours per cow in the largest with a fairly regular decline through the intermediate size groups. Total labour costs followed the same pattern but not in exact proportion because the bigger responsibilities carried by cowmen in larger herds are reflected in their higher cost per hour. The use of labour in dairying is discussed in more detail in Section IV.

The other main input, feed, showed less variation in cost per cow by herd size group, but the low yield noted earlier in the smallest herd size groups is reflected in higher feed costs per gallon. The size groups of between 20 and 70 cows showed a noticeably uniform average feed cost per gallon. It may be noted at this point that as Table 14 shows a change of method involving the charging of home-grown concentrates at market prices would make but little difference to the pattern of average costs and margins in the various herd size groups.

However, as regards the types of feed used, differences between large and small herds were more distinct. The larger herds used a higher proportion of home-grown concentrates, more silage and less hay and straw than the smaller ones (see Table 15 on p. 23). This reflects differences in farm size and associated preferences in methods of grass conservation. The relationship between feed inputs, yields and margins are discussed in detail in Section III.

The average level of miscellaneous costs per cow, which made up approximately 20 per cent of total costs in all herd size groups, did not differ widely in total from one herd size group to another. In general terms, the charges—each relatively small—for buildings, machinery, vetinerary services and general dairy expenses in the larger herds were higher per cow compared with smaller herds, reflecting the rather more sophisticated operations of the larger herd. The biggest single item in the list however, is the share of farm overheads consisting mainly of overhead labour charges. Being assessed as a fixed proportion of direct labour costs, this was lower in the larger herds and therefore offset the higher costs already mentioned. The detailed figures are shown in Appendix I.

The average cost of herd replacement was higher in the largest herds than in the smallest, reflecting mainly a bigger drop in the value of cows during their life in the large herds. This is probably attributable to differences in buying and selling policies. The details of this aspect of milk costs are discussed in Section II.

TABLE 14

Estimated Effect of charging Home-grown Concentrates at Market Price Compared with Cost of Production

Herd Size (cows per herd)		6–9·9	10–19·9	20–29·9	30–39·9	40–49·9	50–59·9	60–69·9	70–99·9	100 and over	Total
Increase in feed cost per cow when home-grown concentrates are at market price	(£)	0·25	1·45	1·40	2·20	2·20	1·85	3·00	2·55	1·80	1·85
	%	0·5	2·5	2·5	3·5	4·0	3·0	5·0	4·5	3·5	3·0
At Cost of Production	Total costs per cow (£)	127·50	119·05	110·80	112·75	103·95	108·85	109·40	103·05	103·45	110·75
	Net margin per cow (£)	−7·10	11·90	26·95	29·40	37·00	36·35	36·95	44·65	44·55	29·05
At Market Value	Total costs per cow (£)	127·75	120·50	112·20	114·95	106·15	110·70	112·40	105·60	105·25	112·60
	Net margin per cow (£)	−7·35	10·45	25·56	27·20	34·80	34·50	33·95	42·10	42·75	27·20

The range of differences described above led to the small herd size groups showing lower net margins per cow, per gallon and per livestock acre than the larger herd size groups. If, however, unpaid labour is not counted as a cost and family income per cow is calculated, the differential between the small and large herd size groups is much narrower because, in the smaller herds, upwards of four fifths of all labour is unpaid. The difference between large and small scale milk production was therefore that, the larger herds obtained only a slightly higher family income per cow, almost all of which was a reward for management and the use of capital; whilst in the smaller herds, on the other hand, most of the family income represented a reward for manual labour.

III. FEEDING THE DAIRY HERD

Introduction

The most important single aspect of milk production is the feeding of the herd. This is so for two reasons. Firstly, because the cost of food accounts for a little over half the cost of producing a gallon of milk; secondly, because the system and level of feeding are important determinants of the total quantity of milk produced from a herd. This in its turn has a significant bearing on the productive efficiency of the resources used such as direct labour, buildings, equipment and general overheads. On average, 55 per cent of total food cost is accounted for by purchases, mainly of concentrates but including also small quantities of hay, straw and succulents of various kinds. Grazing, on the other hand, accounts for only 17 per cent of total food cost although it contributes a proportionately much larger share of total nutrient requirements.

Most questions and controversies about the feeding of dairy cows are concerned, in one way or another, with the relationship between food input and milk output, the extent to which forage and grazing can take the place of concentrates without incurring significant losses in production, and the optimum level of stocking intensity. Neither the problems nor their solutions are independent of one another. They are best considered as part of a single production strategy, the purpose of which is to make the best possible use of the individual farmer's resources and to achieve as many as possible of the goals which the farmer has set for himself. But there can be neither simple clear-cut answers not unqualified recommendations regarding the questions raised.

By virtue of the random nature of the sample, the results of this investigation can be regarded as providing unbiased estimates of the various structural characteristics and input/output ratios as they exist, on average, within the designated groups and sub-groups. There is, however, one important matter arising in connection with their interpretation. If thought is being given to the likely changes in output, costs and margins, which would follow as a result of a herd change from one group in a table to another, one might ask whether it is permissible to regard the average results for the group into which it is contemplated moving the herd, as the probable outcome of making such a change. The safe answer to this question is a firm 'No', because the factors defining the groups are unlikely to be the only ones on which the average values of the groups depend. But at the same time it would not be unreasonable to use these results for the purpose of viewing this kind of problem from the opposite direction. When an individual farmer has under consideration a change in herd policy about which he has certain expectations, if these do not match up to the average performance for herds in the group corresponding to the proposed new policy, then it would be prudent to make a careful reappraisal of the proposed change.

Throughout this section considerable use is made of two- and three-way classification tables, but as a research technique they have very definite limitations. They are not well suited to the task of investigating problems in which a large number of factors are involved, particularly when, as in this instance, the sample as a whole is a comparatively small one. Moreover, the

TABLE 15

Average Feed Costs, Returns and Margins over Feed Cost by Herd Size Group
(£ per cow, d. per gallon and £ per livestock acre)

Item	Herd Size (cows)																			
	6·0–9·9		10·0–19·9		20·0–29·9		30·0–39·9		40·0–49·9		50·0–59·9		60·0–69·9		70·0–99·9		100·0 & over		Total	
Number of herds	17		92		81		70		51		41		23		38		21		434	
Herd size cows	8·3		15·6		24·9		34·8		44·4		54·9		64·6		82·2		138·6		28·6	
Farm size acres	43		75		92		124		157		221		298		337		557		115	
Labour requirements hours per cow	162		118		94		87		72		72		65		61		62		88	
Seasonality winter gal as % of year	41·3		43·8		46·6		47·1		47·7		47·3		50·0		49·5		48·6		46·9	
Yield gal per cow	684		762		802		828		812		840		837		850		848		809	
Dry cows % of total cows	22		18		18		17		18		17		17		17		18		18	
Stocking rate forage acres per cow	2·26		1·96		1·76		1·79		1·68		1·74		1·78		1·69		1·64		1·79	
Stocking rate livestock acres per cow	2·32		2·08		1·84		1·95		1·84		1·86		1·99		1·86		1·78		1·92	
Purchased concentrates cwt per cow	17·5		19·7		19·8		20·8		19·5		19·3		18·1		17·0		14·7		19·1	
Home-grown concentrates ,, ,, ,,	1·1		3·1		2·5		4·3		4·4		3·7		6·0		5·4		4·1		3·7	
Total concentrates ,, ,, ,,	18·6		22·8		22·3		25·1		23·9		23·0		24·1		22·4		18·8		22·8	
Hay and straw ,, ,, ,,	30·2		30·2		26·9		25·7		19·6		20·3		21·9		16·6		10·9		23·5	
Roots, green fodder and other ,, ,, ,,	8·4		11·7		7·8		10·6		10·4		9·3		14·6		13·5		11·6		10·5	
Kale ,, ,, ,,	11·9		16·6		17·1		14·7		11·9		19·0		31·5		27·6		25·5		18·2	
Silage ,, ,, ,,	0·4		7·3		11·9		19·6		34·9		42·7		36·4		49·2		73·6		26·6	
	£	d.	£	d.	£	d.	£	d.	£	d.	£	d.	£	d.	£	d.	£	d.	£	d.
Foods: Purchased	33·80	11 9	34·75	11·0	34·60	10·4	35·40	10·3	33·05	9·8	33·30	9·5	31·45	9·0	29·30	8·3	24·85	7·1	33·05	9·8
Home-grown	12·10	4·2	15·95	5·0	14·30	4·3	16·35	4·7	16·50	4·9	16·55	4·7	19·25	5·5	18·05	5·1	17·10	4·8	16·10	4·8
Grazing	8·25	2·9	8·90	2·8	9·10	2·7	9·50	2·8	9·85	2·9	11·10	3·2	11·15	3·2	10·00	2·8	12·15	3·4	9·80	2·9
Total	54·15	19·0	59·60	18·8	58·00	17·4	61·25	17·8	59·40	17·6	60·95	17·4	61·85	17·7	57·35	16·2	54·10	15·3	58·95	17·5
Gross Returns	120·40	42·2	130·95	41·3	137·80	41·3	142·15	41·2	140·95	41·6	145·20	41·5	146·35	42·0	147·70	41·7	148·00	41·9	139·75	41·5
Gross returns per livestock acre	51·90		63·10		74·75		73·00		76·80		78·00		73·65		79·30		83.25		72·75	
Margin over feed costs per cow	66·25		71·35		79·80		80·90		81·55		84·25		84·50		90·35		93·90		80·80	
Margin over feed costs per livestock acre	28·55		34·30		43·35		41·50		44·35		45·30		42·45		48·60		52.75		42·10	

results, presented in tabular form, become difficult to evaluate when the number of classes and sub-groups becomes large. These limitations can be largely avoided by the use of more sophisticated methods of analysis which permit the simultaneous consideration of a larger number of factors and make more efficient use of a sample of any given size. Such techniques* were employed in this study for the purpose of making a more thorough investigation of the possible relationships between production and a number of qualitative and quantitative variables that describe and measure the environment within which, on the sample farms, the production process occurred. The results of these further analyses are woven into the discussions which follow.

The influence of herd size

The sample was divided into 9 herd size groups. The average number of cows was 8·3 in the smallest group and 138·6 in the largest group. Having regard to the very wide size range covered by these groups, the corresponding variations in feed costs and margins over feed costs, both per cow and per gallon, look surprisingly small.† There are indications that larger herds contained cows of better quality, that is, of higher milk producing potential, than did smaller herds. Furthermore, cows in larger herds, while being given about the same quantity of concentrates per head as cows in small herds, receive 10 per cent to 15 per cent more fodder dry matter during the winter. These two factors, cow quality and winter-fodder, probably explain the higher yields and margins over feed cost per cow in the larger herds, but the differences appear to be significant only when comparing the performance of very small and very large herds. Within the herd-size range of 20 to 70 cows, there were no significant differences in performance with respect to yield and margin over feed per cow and per gallon.

There are several good reasons for expecting large herds to have an advantage over small herds with respect to the procurement of cheap feedingstuffs and their efficient conversion into milk. For example, it is generally assumed that owners of large businesses, i.e., large herds, are able to purchase their feedingstuffs at a significantly lower price per cwt than can farmers with small businesses, i.e., small herds. The figures in Table 16 do little to support this proposition. The average price per cwt paid for compounds by farmers with herds of between 60 and 70 cows was not significantly different from that paid by farmers with herds of between 6 and 20 cows. Cows in large herds received approximately the same quantity of concentrates per head as did cows in small herds but in large herds a greater proportion of home-grown grain was included in the concentrate ration. Even when entered at market price rather than at cost of production, the effect of the inclusion of a substantial proportion of home-grown grain was to reduce the cost per cwt overall. This was one very clear cost advantage associated with large herds.

Excluding grazing, cows in very large herds received about 15 per cent more dry matter per head in the form of bulk foods than did cows in very small herds and, over the year as a whole, they produced on average about 15

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*The techniques used included multiple regression and analysis of variance.

†Most of the discussion under this heading is based where possible on a recalculation of feed costs and margin over feed costs using market value of home-grown cereals in place of costs of production.

TABLE 16

Feed Use according to Herd Size Group

Feed Type		Herd Size (cows)									
		6·0–9·9	10·0–19·9	20·0–29·9	30·0–39·9	40·0–49·9	50·0–59·9	60·0–69·9	70·0–99·9	100·0 & over	Total
Concentrates:											
Purchased:											
compounds	cwt per cow	14·60	16·38	16·76	16·76	13·27	14·26	13·11	11·83	9·94	14·81
	lb per gallon	2·39	2·41	2·34	2·27	1·83	1·90	1·76	1·56	1·31	2·05
	shillings per cwt	35·4	35·4	34·8	34·8	35·0	33·4	35·2	33·4	33·2	34·6
straights	cwt per cow	2·85	3·35	3·02	4·07	6·24	5·07	5·01	5·20	4·76	4·26
	lb per gallon	0·47	0·49	0·42	0·55	0·86	0·68	0·67	0·68	0·63	0·59
	shillings per cwt	30·0	27·4	25·5	25·4	26·6	29·2	25·6	29·6	25·8	26·8
Home-grown*	cwt per cow	1·09	3·07	2·53	4·28	4·40	3·70	6·00	5·38	4·05	3·73
	lb per gallon	0·18	0·45	0·36	0·58	0·61	0·49	0·80	0·71	0·54	0·52
	shillings per cwt	21·5	21·5	21·5	21·5	21·5	21·5	21·5	21·5	21·5	21·5
Total concentrates	cwt per cow	18·54	22·80	22·31	25·11	23·91	23·03	24·12	22·41	18·75	22·80
	lb per gallon	3·04	3·35	3·12	3·40	3·30	3·07	3·23	2·95	2·48	3·16
	shillings per cwt	33·7	32·3	32·0	31·0	30·3	30·6	29·9	29·7	28·4	31·0
Bulk Feeds:											
Hay:											
purchased	cwt per cow	5·08	1·28	1·53	1·10	1·63	1·06	1·30	1·88	1·01	1·49
	shillings per cwt	13·2	10·6	12·6	8·0	10·8	11·2	7·6	8·8	12·6	10·8
home-grown	cwt per cow	23·69	27·90	24·68	24·05	16·48	18·40	18·21	12·67	8·91	20·96
	shillings per cwt	7·4	6·6	6·8	6·6	6·8	7·0	6·8	6·8	7·2	6·8
Straw	cwt per cow	1·42	0·98	0·70	0·57	1·47	0·80	2·35	2·01	1·02	1·09
	shillings per cwt	2·2	2·6	3·0	2·0	3·2	1·4	2·2	2·2	2·0	2·4
Roots and green fodder	cwt per cow	7·05	7·87	5·20	5·59	7·16	1·91	4·94	7·07	3·90	5·82
	shillings per cwt	1·8	2·0	2·2	2·2	2·2	2·8	1·8	2·0	2·4	2·2
Kale	cwt per cow	11·94	16·57	17·05	14·66	11·92	18·97	31·50	27·60	25·51	18·23
	shillings per cwt	2·2	1·6	1·4	1·2	1·4	1·4	1·2	1·4	1·4	1·4
Silage	cwt per cow	0·39	7·26	11·89	19·61	34·89	42·68	36·44	49·25	73·60	26·64
	shillings per cwt	1·4	2·2	1·8	1·6	2·2	1·8	1·8	1·8	1·8	2·0
Other feeds	cwt per cow	1·31	3·81	2·59	5·00	3·20	7·42	9·66	6·38	7·67	4·71
	shillings per cwt	3·2	2·4	3·6	2·8	4·6	3·6	3·2	2·8	3·6	3·2

*Charged at market value.

per cent more milk. Compared with the two smallest herd size groups, large herds were stocked at a higher density per acre which reflected advantageously on margins over feed cost per livestock acre. From 20 cows upwards there appeared to be no significant differences in stocking rates between the herd size groups.

The conclusions are that, with the exception of the very small and the very large herds, the influence of herd size on the costs and efficiency of feeding the herd is not very great and less than might be expected. If there are potential advantages, then it would appear that the majority of owners of large herds fail to make the best use of their advantageous position. While it is true that large herds are more profitable per gallon, per cow and per acre than small herds, by far the most important factor in this situation is the very substantial saving in labour costs which is achieved on the larger herds. This subject is dealt with in a separate discussion on labour in milk production.

The Feeding of Concentrates

Over the whole sample, the average quantity of concentrates fed per cow was 22·8 cwt; sufficient, on conventional standards, to produce 638 gallons of milk, or nearly 80 per cent of the average total quantity of milk produced per cow. Starting from this situation it is possible to reach the conclusion that only 171 gallons of milk (plus maintenance) per cow were obtained from grazing and other bulk foods. The validity of pre-empting milk at a standard rate of 1 gallon to 4 lb of concentrates fed, thereby imputing only the residual to other foods fed, is somewhat doubtful. It is, of course, true that concentrates are fed solely, or mainly for production purposes, and that a feeding rate of 3–4 lb per gallon, according to type, is a widely recognized standard and one which producers in general are believed to follow in practice. But probably the most powerful reason for the adoption of this particular method of partitioning milk produced between concentrates and bulk feed is the fact that any other method would appear to involve the formidable task of measuring the intake of nutrients from grazing. But even if one disagrees with both the method and the results, which give concentrates the credit for producing 80 per cent of the yield, leaving only 171 gallons per cow to come from the rest of the foods fed, they do bring out an important point. It is very clear that there is a serious divergence between the total quantity of food fed and on offer by way of grazing and the quantity of milk actually produced, when considered in the light of what are now conventional expectations—such as 'maintenance and 3–4 gallons from grass', or 'maintenance plus 1–2 gallons from silage'.

In 19 per cent of herds in England and Wales, cows received on average less than 15 cwt of concentrates per head; whilst at the other end of the range, 18 per cent of herds were fed over 30 cwt per cow. Cows in herds receiving the higher levels of concentrates tended to produce more milk than less intensively fed cows, but not sufficient to do more than offset the higher feed costs.

There were no significant differences between the groups in margin over feed cost per cow. The likely explanation is that in the majority of intensively fed herds, the level of nutrition is not matched by the inherent capacity of the cows to produce milk. The situation also tends to cast some doubt upon the popular concept of dairy farmers carefully adjusting the daily quantities of

TABLE 17

Margins over Feed Costs according to Concentrates Fed and Bulk Feed Acres per Cow

Forage acres and equivalent acres of hought bulk feed per cow	Item	Concentrates (cwt per cow)					
		Less than 15·0	15·0–19·9	20·0–24·9	25·0–29·9	30·0 and over	Total
Less than 1·50	Number of herds	13	19	31	25	21	109
	Herd size (cows)	26	40	32	30	32	32
	Yield (gallons per cow)	736	807	798	834	912	822
	Margin over feed cost (£ per cow)	88·8	90·6	83·8	84·7	86·4	86·4
	Margin over feed cost (£ per livestock acre)	59·1	67·3	58·3	57·8	58·0	59·8
1·50–1·74	Number of herds	10	25	28	14	24	101
	Herd size (cows)	30	33	37	32	29	32
	Yield (gallons per cow)	631	772	826	865	958	832
	Margin over feed cost (£ per cow)	78·4	85·9	88·8	88·7	91·6	87·8
	Margin over feed cost (£ per livestock acre)	46·6	50·0	52·0	50·9	52·2	50·9
1·75–1·99	Number of herds	14	29	21	13	12	89
	Herd size (cows)	29	27	33	36	25	29
	Yield (gallons per cow)	700	773	798	869	861	792
	Margin over feed cost (£ per cow)	84·2	82·7	82·0	82·1	75·4	81·8
	Margin over feed cost (£ per livestock acre)	44·1	42·7	43·6	43·6	37·2	42·6
2·00–2·24	Number of herds	12	11	11	9	10	53
	Herd size (cows)	30	30	25	30	26	28
	Yield (gallons per cow)	684	693	861	835	995	801
	Margin over feed cost (£ per cow)	82·1	72·4	87·9	71·6	89·4	80·7
	Margin over feed cost (£ per livestock acre)	40·3	34·1	40·9	34·2	40·6	38·1
2·25 and over	Number of herds	16	27	12	15	12	82
	Herd size (cows)	14	26	23	21	28	22
	Yield (gallons per cow)	679	767	746	892	863	783
	Margin over feed cost (£ per cow)	72·7	74·3	70·3	80·7	63·7	73·0
	Margin over feed cost (£ per livestock acre)	26·1	26·8	25·0	31·8	23·7	26·8
Total	Number of herds	65	111	103	76	79	434
	Herd size (cows)	24	30	31	29	29	29
	Yield (gallons per cow)	690	769	807	857	922	809
	Margin over feed cost (£ per cow)	81·5	81·6	83·7	82·7	83·6	82·7
	Margin over feed cost (£ per livestock acre)	40·9	40·7	45·6	44·4	44·0	43·0

concentrates fed to the yields of individual cows. Of course, farmers, and all those who have discussed the subject with them, know that there are many reasons given for feeding concentrates, and by no means all of them are connected with either yesterday's actual yields or tomorrow's expectations.

Given a herd with the capacity to produce an average of 1,000–1,200 gallons per cow per annum, the argument about high concentrate feeding takes on a different aspect. In a sub-class of 44 herds, with an average yield per cow of 1,000–1,200 gallons, the average rate of concentrate feeding was as high as 31·7 cwt per cow; yet in spite of this, the average margin over feed cost was £104 per cow, compared with an average of only £84 per cow for *all* herds receiving 30 cwt and over of concentrates per cow. Some farmers, with very high standards of management and cows of high quality, were able to produce 1,000–1,200 gallons per cow using significantly less than 31·7 cwt, and clearly this was even more profitable. But it in no way contradicts the wisdom of feeding 31·7 cwt in order to produce 1,000–1,200 gallons if, under the prevailing management and herd conditions, this is the only way it can be done.

A surprising feature of concentrate consumption was the large amount fed during the summer period, from April to September. The average amount fed in England and Wales was 8·4 cwt per cow, which accounted for as much as 37 per cent of total concentrates fed per annum.

The results of farm scale experiments* on the feeding of concentrates to cows while at grass in the summer have indicated that, given an adequate supply of young leafy grass, the response in milk production to supplementary feeding with concentrates is too small to be economically worthwhile. But a recent analysis of grassland recording data on a sample of 64 Cheshire dairy farms† suggested that, on these farms, the feeding of concentrates during the summer period had been accompanied by an economically worthwhile increase in milk production. The explanation of this apparent contradiction between experimental and commercial farm experience probably lies in the superlative grassland conditions appertaining on the former and is perhaps best summed up in the qualifying phrase 'an adequate supply of young leafy grass'. On commercial farms this may describe the grassland situation for 8, 10 or even 12 weeks in the year, but it is not the common experience for this state of affairs to persist for a much longer period.

The level of summer concentrate feeding was not, as one might have expected, associated with the seasonal pattern of production. Obviously, in herds with high quality cows and a bias towards spring calving, summer concentrate feeding may have to be generous in order to exploit the herd potential. But there is no economic purpose served in summer feeding concentrates to the previous year's autumn calvers until they are close to calving again in the following autumn. It seems, therefore, that an appreciation of *when* to feed concentrates is just as important as knowing how much to feed in total.

The chief constraint under which most dairy farmers operate is generally thought of as being the fixed size of the farm, therefore margins per acre may

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*W. Holmes and J. G. W. Jones. 1964. *The efficient utilization of fresh grass. Proc. Nutr. Soc.* 23; 88–89.

†The Determinants of grassland productivity, Keith Cowling, Dept. of Agricultural Economics, University of Manchester, Bulletin No. 111.

be a more important criterion than margins per cow for the obvious reason that it will usually be easier to increase the herd size than the farm size.

The average figures of herd size, yield and margins, contained in the bottom row of Table 17 are based on the whole sample of herds classified according to the quantity of concentrates fed per cow. Higher yields per cow are associated with higher concentrate inputs, but the gains in yield are almost completely offset by the higher feed costs. There are, in consequence, no significant differences between the groups in margin over feed cost per cow, and only a very slight suggestion of differences between the groups in margin over feed costs per livestock acre. The far right-hand column, in which the herds are classified by a measure of stocking rate, shows a very different result. Although once again the situation with respect to margin over feed cost per cow is not very clearly defined, there can be no doubt whatsoever that higher stocking rates are associated with higher margins over feed per livestock acre.

The same Table throws some light on the relative importance and the combined effects of concentrate usage and stocking rate. Moving diagonally from bottom left (2·25 and over forage acres* and under 15 cwt of concentrates per cow) to top right (under 1·5 forage acres and 30 cwt and over of concentrates per cow) there is a steady increase in margin over feed cost per livestock acre from £26·1 to £58·0, as stocking rate and concentrate consumption per cow rise simultaneously. Moving up the opposite diagonal, from bottom right (2·25 forage acres and over and 30 cwt and over of concentrates per cow) to top left (under 1·5 forage acres and less than 15 cwt of concentrates) the margin over feed cost per livestock acre also rises, from £23·7 to £59·1. The situation described in this second manoeuvre is one of increasing rates of stocking combined with declining rates of concentrate feeding per cow. There appears to be comparatively little difference between the options as represented by these two diagonals, but the really important element in the situation is clearly the stocking rate. This tends to be confirmed by the results of a more detailed and advanced analysis which suggest that (in Friesian herds) at the average stocking level, a 5 per cent increase in stocking was associated with an increase in margin over feed cost of £2·7 per livestock acre.

Bulk Feeds Versus Concentrates

The 1960–62 edition of *Costs and Efficiency in milk Production* contained a discussion on systems of feeding based on an analysis in which costed herds were classified as either 'traditional' or 'bulk-fed', according to whether the rate of concentrate feeding was above or below 4 lb per gallon in winter and 2 lb per gallon in summer. This classification has been elaborated in the 1965–66 analysis by dividing the sources of nutrients into three classes, concentrates, bulk foods and summer grazing. The results are presented in Tables 18 and 19. In Table 18 the sample herds are first classified by reference to two of the three sources, concentrates and bulk foods fed per cow. The latter is expressed in cwt of dry matter and excludes grazing. The numbers of herds†

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*Forage acres in Table 17 refer to forage acres plus the equivalent acres of bought bulk feed.

†The distribution of herds in Table 18 closely resembles that of the Raised Sample and therefore is a reliable estimate of the frequency with which the combinations of concentrate and bulk feeding occur in all herds in the population. The pattern shows no statistically significant association between high and low feeding rates of the two types of food.

TABLE 18

Yields, Feed Costs and Margins over Feed Costs according to Concentrates and Bulk Food Fed

Fodder (cwt dry matter per cow)		Concentrates (cwt per cow)			
		Under 15 (low)	15·0–24·9 (medium)	25·0 and over (high)	Total
Less than 25·0 (low)	Number of herds	18	56	38	112
	Yield (gallons per cow)	705	773	831	780
	Feed cost (£ per cow)	36·0	50·5	66·2	53·3
	Margin over feed cost (£ per cow)	87·1	83·5	80·2	83·0
	Margin over feed cost (£ per livestock acre)	44·1	48·3	47·0	47·1
25·0–34·9 (medium)	Number of herds	33	93	83	209
	Yield (gallons per cow)	670	769	901	805
	Feed cost (£ per cow)	38·2	52·2	69·7	56·9
	Margin over feed cost (£ per cow)	79·0	81·2	84·2	82·0
	Margin over feed cost (£ per livestock acre)	40·7	42·3	44·0	42·7
35·0 and over (high)	Number of herds	14	65	34	113
	Yield (gallons per cow)	714	826	954	843
	Feed cost (£ per cow)	47·3	56·7	76·8	61·4
	Margin over feed cost (£ per cow)	79·5	84·0	84·0	83·4
	Margin over feed cost (£ per livestock acre)	37·3	39·8	41·9	40·0
Total	Number of herds	65	214	155	434
	Yield (gallons per cow)	690	786	891	809
	Feed cost (£ per cow)	39·6	53·1	70·4	57·1
	Margin over feed cost (£ per cow)	81·5	82·6	83·0	82·7
	Margin over feed cost (£ per livestock acre)	40·9	42·9	44·2	43·0

TABLE 19

Margins over Feed Cost per Cow and per Livestock acre according to Concentrates, Fodder and Grazing Intensity

Fodder (cwt dry matter per cow)	Grazing acres per cow	Item	Concentrates (cwt per cow)		
			Less than 15·0	15·0–24·9	25·0 and over
			£	£	£
Less than 25·0	Less than 0·75	Margin over feed per cow	(a)	(a)	(a)
		Margin over feed per livestock acre			
	0·75–1·24	Margin over feed per cow	97·8	83·0	81·2
		Margin over feed per livestock acre	53·1	51·4	51·5
	1·25 and over	Margin over feed per cow	73·1	80·0	73·8
		Margin over feed per livestock acre	32·8	38·3	35·4
25·0 to 34·9	Less than 0·75	Margin over feed per cow	(a)	(a)	(a)
		Margin over feed per livestock acre			
	0·75–1·24	Margin over feed per cow	88·5	85·4	88·1
		Margin over feed per livestock acre	51·6	50·1	51·9
	1·25 and over	Margin over feed per cow	66·5	74·4	77·2
		Margin over feed per livestock acre	29·3	31·8	33·2
35·0 and over	Less than 0·75	Margin over feed per cow	(a)	89·4	95·8
		Margin over feed per livestock acre		59·6	67·3
	0·75–1·24	Margin over feed per cow	(a)	86·4	82·0
		Margin over feed per livestock acre		45·6	44·2
	1·25 and over	Margin over feed per cow	(a)	77·4	79·7
		Margin over feed per livestock acre		27·8	31·9

(a) Less than 8 herds in the cell.

with the various combinations of concentrate and bulk feeding suggest that the rates at which the two types of food are fed vary quite independently of each other. There is no evidence of the use of high bulk fodder intake as compensation for low rates of concentrate feeding.

The variation in average margins over feed cost provides little evidence of any decisive advantage associated with high bulk feeding. In fact, low bulk feeding gives the highest margin over feed cost per livestock acre at each level of concentrate feeding. Indeed, if we trace the substitution process, i.e., follow the path of diminishing concentrates fed and increasing fodder dry matter fed, along the diagonal from the top right cell, corresponding to high concentrates and low fodder dry matter fed per cow, down to the cell in the next to the bottom row, corresponding to low concentrates and high fodder dry matter per cow, we find that there are no significant changes in margin over feed cost per cow, but there are substantial reductions in the margin over feed cost per livestock acre.

In Table 19 the third variable, the rate of summer stocking (grazing acres per cow) is introduced.

No averages are given for cells which contained less than 8 herds. The results again underline the paramount importance of stocking rate. For all combinations of concentrates and fodder dry matter fed per cow, higher margins over feed, both per cow and per livestock acre, are found in herds summer stocked at higher levels of intensity.

Utilized Starch Equivalent

Estimates of Utilized Starch Equivalent (U.S.E.) from grass and/or fodder acres are frequently employed as a measure of technical efficiency. The estimates are biased by the method of calculation in which some foods, notably concentrates, are given a utilized value equal to one hundred per cent of their theoretical value, which is then subtracted from the estimated total requirement, leaving a residual requirement to be credited to the nutrient sources not already accounted for in the calculation. For comparison with similar calculations that are published elsewhere from time to time, the estimated U.S.E. values in cwt per forage acre, calculated from the random sample results; together with their estimated cost per cwt, are presented in the form of a two-way classification in Tables 20 and 21.

Over the sample as a whole, the estimate of average U.S.E. produced per forage acre was 13·4 cwt, ranging from 9.2 cwt on farms with low summer stocking and high fodder and concentrate usage to 30·2 cwt on farms with high summer stocking and low fodder and concentrate usage. The average figure of 13·4 cwt may strike people as surprisingly low. It corresponds closely with the findings of the Caine Committee on Grassland Utilisation some nine years ago, but falls short of the 17 cwt per acre estimated as the average output of U.S.E. of grassland in England and Wales at the present*. The average cost of some 18*s.* per cwt U.S.E. from forage may be compared with approximately 30*s.* per cwt U.S.E. from barley charged at market value† and around 53*s.* per cwt U.S.E. from standard dairy cake.

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*Dr. H. K. Baker: Presidential Address—Journal of the British Grassland Society, Volume 22, No. 1, March 1967.

†With barley charged at cost of production, it is estimated that the cost per cwt of U.S.E. from barley would be approximately 20*s.*

TABLE 20

Utilized Starch Equivalents (U.S.E) per Forage Acre and Cost per cwt U.S.E. According to Concentrates and Fodder Dry Matter Fed

Fodder (cwt dry matter per cow)	Item	Concentrates (per cwt cow)			
		Less than 15·0	15·0–24·9	25·0 and over	Total
Less than 25·0	U.S.E. from forage (cwt per forage acre)	15·6	15·3	12·1	14·4
	Cost of forage U.S.E. (shillings per cwt)	12·5	15·5	18·2	15·6
25·0–34·9	U.S.E. from forage (cwt per forage acre)	15·7	13·9	11·9	13·4
	Cost of forage U.S.E. (shillings per cwt)	14·5	16·6	21·0	17·7
35·0 and over	U.S.E. from forage (cwt per forage acre)	13·3	13·2	10·3	12·4
	Cost of forage U.S.E. (shillings per cwt)	20·1	20·5	27·7	22·1
Total	U.S.E. from forage (cwt per forage acre)	15·1	14·0	11·6	13·4
	Cost of forage U.S.E. (shillings per cwt)	15·1	17·5	21·7	18·3

TABLE 21

Utilized Starch Equivalents (U.S.E.) per Forage Acre according to Fodder Dry Matter and Summer Stocking Rate

Fodder (cwt dry matter per cow)	Item	Grazing (acres per cow)		
		Under 0·75	0·76–1·24	1·24 and over
Less than 25·0	U.S.E. from forage (cwt per forage acre)	24·3	15·3	11·9
	Cost of forage U.S.E. (shillings per cwt)	16·7	15·2	15·8
25·0–34·9	U.S.E. from forage (cwt per forage acre)	19·3	15·4	10·9
	Cost of forage U.S.E. (shillings per cwt)	15·8	17·3	18·6
35·0 and over	U.S.E. from forage (cwt per forage acre	17·5	13·2	10·2
	Cost of forage U.S.E. (shillings per cwt)	20·4	22·6	22·3

U.S.E. estimates tend to be relatively low in herds where cows are fed high levels of concentrates because, in these herds, the average rate at which concentrates are fed per gallon is itself rather inefficient. High levels of bulk feeding per cow certainly do not improve the U.S.E. performance figures as one might have expected them to do; this is largely due to the fact that there are on average no discernible substitution effects between bulk foods and concentrates fed present in this sample, and also little evidence to indicate that, in the average situation, management succeeds in adjusting total nutrients fed to the herd's production potential and its nutrient requirements.

Increasing the summer stocking rate (grazing acres per cow) appear to have a markedly beneficial effect on estimated U.S.E. per forage acre. Indeed, if one looks carefully at Table 21, it is apparent that in the context of obtaining a high U.S.E. output per forage acre, a high summer stocking rate is capable of offsetting the adverse effect of a combination of average yields, and above average quantities of concentrates and bulk feed fed per cow.

Other Factors associated with Yield and Stocking Density

In the foregoing discussion attention has been drawn to cow quality and yield, and density of stocking as being particularly desirable characteristics because of their association with high margins, either per cow or per livestock acre or both. An attempt was made to investigate these problems further by examining the degree of association between herd to herd variations in these characteristics and other measurable characteristics of herd management and environment.

As was to be expected, there were differences in yield per cow between the breeds, so the investigation was restricted to Friesian herds which were just over half of all the herds costed. The findings which are reported in this section are based on this sub-sample. About half the variation from herd to herd in average yield per cow was associated with differences in the level of concentrates fed; but on the performance of the average herd, the higher yields associated with rates of concentrate feeding above 15 cwt per cow were insufficient to leave any worthwhile margin over the additional cost of feed. This merely underlines the earlier conclusion that the quality of stock or cow management, or both was, *on average*, not high enough to justify rates of concentrate feeding above the 15 cwt per cow level. On the other hand there were a number of good herds under good management in which the margin per cow was much above average in spite of heavy concentrate feeding, which frequently exceeded 30 cwt per cow. But there were also individual herds producing over 1,000 gallons per cow per annum on less than 20 cwt of concentrates per cow. The only other factor of individual importance from the point of view of its association with yield per cow was the average percentage of dry cows in the herd. This is partly an indication of the calving index but is also indicative of undesirably brief lactations in which cows are dry before their time. Calculated on the basis of a 50 cow herd, the average number of dry cows over the year was just under 9. An increase in this figure by one dry cow over the year was associated with a reduction of 13 gallons in the average yield per cow per annum over the whole herd of 50.

Having referred so frequently in this section to the overwhelming importance of a high stocking rate as a means to higher returns, the question arises as to whether there are any management or environmental factors which exhibit a close association with higher than average rates of stocking. As many as nine variables were used in an attempt to find some association between the level of stocking rate and the conditions likely to have a bearing on it, but with little result. The analysis failed, for instance, to produce a statistically significant connection of even modest importance between stocking rate and fertilizer expenditure. Of course, some farms on which fertilizer expenditure was relatively high were also heavily stocked, but there were other farms, also heavily stocked, on which fertilizer expenditure was very small. Likewise relatively low stocked farms were divided into approximately equal proportions between high and low fertilizer users. Whatever the effect of fertilizer use on grass productivity may be, the relationship between fertilizer use and the profitability of milk production is determined by the efficiency with which management uses the grass; a high stocking rate has been shown to be one of the main factors contributing to efficient grass utilization.

The results of further probing into the management and environmental factors associated with variations in U.S.E. produced some interesting figures. For example, after making allowance for the effects of other factors in the situation, farmers on what field workers classed as 'poor' land obtained only 1⅓ cwt less U.S.E. per acre than did farmers who occupied land classed as 'very good'. These quality assessments were intended, as far as was practicable to represent national, not local, standards. An association was found between the levels of U.S.E. and fertilizer expenditure. An additional ¼ cwt of U.S.E. per forage acre was found to be associated with an additional expenditure on fertilizers of £1 per grazing acre‡, an increase on average fertilizer expenditure of 33 per cent. On the other hand, an increase of only 10 per cent in stocking per forage acre over the average rate was accompanied by an increase of 1 cwt in U.S.E. per forage acre.

Seasonality

Decisions on the farm concerning the pattern of seasonal production are very much influenced by feeding policy and the home-grown feed supply situation. There often appears to be a rule of thumb applied to this problem which recognizes advantages in summer production for the mainly grassland and higher rainfall regions of the western side of the country, while being in favour of some degree of emphasis towards winter milk in the arable and drier areas of the eastern side.

The more extreme summer producers tend to be the smaller herds and so, as a preliminary step to analysing the effects of seasonality on costs and margins, the effects of herd size and of breed were removed from the results of all sample farms.* Thus the estimates of the average costs and margins for different seasonality groups are independent of variations between these groups due to variations in herd size and breed. Feed costs increased from £41·1 per cow in the extreme summer group (producing less than 36 per cent winter milk) to £60·5 per cow in the group producing 52 to 56 per cent winter milk. Extreme winter producing groups (over 56 per cent winter milk) did not incur additional costs for feed compared with the 52 to 56 per cent group. Variations in the seasonal pattern of production account for very nearly half of the variation between herds in feed costs per cow. There were significant differences between seasonality groups in net margin per livestock acre, the figures ranging from an average of £11·3 in the group of herds producing 36 to 40 per cent winter milk to £18·4 in the group of herds producing between 52 per cent and 56 per cent winter milk. Fifty-six per cent winter milk appeared to be the optimum proportion, as beyond this point net margins tended to decline.* The association between net margin per livestock acre and seasonality is related to the high stocking levels existing on farms having higher proportions of winter milk. The connection between net margin per cow and seasonality was very slight and not statistically significant.

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*This was done by the method of fitting constants to the crude data.

‡ On this basis the marginal cost of U.S.E. would be £80 per ton which is much higher than the £53 per ton which was found to be the average cost for U.S.E. in the form of a standard dairy compound.

TABLE 22

Costs and Margins by Seasonality of Milk Production†*

Seasonality (per cent winter milk)	No. of herds	Feed costs	Gross costs	Net margin	
		per cow	per cow	per cow	per livestock acre
		£	£	£	£
Less than 36·0	35	41·1	92·8	‡	‡
36·0–39·9	32	50·0	106·2	19·9	11·3
40·0–43·9	92	52·2	107·0	19·7	10·9
44·0–47·9	99	53·5	107·4	20·1	10·9
48·0–51·9	88	57·1	113·6	24·1	14·8
52·0–55·9	52	60·5	115·7	28·7	18·3
56·0–59·9	26	58·4	114·1	23·4	16·4
60·0 and over	10	60·1	120·9	‡	‡
All herds	434	54·1	109·7	22·3	13·5

*Seasonality is defined as the percentage of total milk produced in the months October to March.

†With herd size and breed effects removed.

‡No results have been given in cell where the standard error of estimate of the mean was greater than 20 per cent of the mean.

Breeds

The various breeds were represented in the survey in very close accord to their relative importance in the England and Wales cow population as a whole. But as Friesian, Mixed breeds and Cross breds accounted for 81 per cent out of a total costed sample of 434 herds (the corresponding proportion for England and Wales as a whole was reported to be 78 per cent in 1963/64), there were too few herds remaining to permit their division into sub-groups for the purposes of comparing their standards of performance.

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* These conclusions relate specifically to 1964/65 milk prices. A change in relative seasonal prices for milk might produce a different result in terms of economic optimum proportions of winter and summer milk.

IV. LABOUR IN MILK PRODUCTION

The Trend in Labour Requirements

Labour requirements per cow have declined in recent years as a result of technological advances in dairy farming. These advances have also resulted in a steady growth in average herd-size, from 15 cows in 1942 to over 28 cows in 1965.

Table 23 shows both the effect of herd size on total labour requirements and the changes that have taken place within these size groups over the last 16 years. The average labour requirement in all size groups has been reduced. But it is clear also that there have been considerable economies of scale operating throughout the period under review.

TABLE 23

Labour Hours per Cow in Herds of Different Sizes
1950/51 *to* 1965/66

Herd size Average number of cows	Average labour hours per cow			
	1950/51	1955/56	1961/62	1965/66
less than 10·0	212	201	162	162
10·0–19·9	162	142	124	118
20·0–29·9	156	129	103	94
30·0–39·9	140	114	97	87
40·0–49·9	136	109	83	72
50·0–59·9	125	106	79	72
60·0 and over	117	113	82	62
all herds	142	124	99	88

Family Labour

In Table 24 changes in the relative importance of family labour, that is the labour of the farmer, his wife and other relatives, have been analysed for a number of years. It will be seen that for all sizes of herd, with the exception of the largest, the cost of family labour as a percentage of total labour cost has risen steadily since 1950/51. Nevertheless, large herds still use proportionately less family labour than the relatively small herds. In the latest year, 1965/66, more information has become available for herds with over 100 cows and this shows that in these herds the use of family labour is negligible.

Another aspect of the labour structure is shown in Table 25. This shows the percentage of herds within each size group that were run entirely by family labour, by a mixed labour force, or solely by paid labour 1965/66. The Table shows a trend towards greater reliance on paid labour with increasing herd size. Nevertheless, the importance of family labour is quite clear. Relating the figures in this table to the distribution of cows among the different sizes of herds, it has been possible to calculate that about half of all dairy herds in England and Wales, containing about one third of the total number of cows, are run entirely by family labour. Only one in ten of all herds are run without any family labour but these contain one-fifth of the national herd.

TABLE 24

Proportion of Labour Costs attributed to Family Labour according to Size of Herd and Year

Size of herd Average number of cows	Family labour cost as percentage of total labour cost				
	1934/35	1950/51	1955/56	1960/61	1965/66
less than 10·0	89	84	91	97	99
10·0–19·9	49	56	68	82	89
20·0–29·9	34	32	40	58	79
30·0–39·9	24	17	26	34	65
40·0–49·9	17	9	14	25	51
50·0–59·9	12	10	10	17	37
60·0 and over	12	6	6	6	10
All herds	26	26	35	44	63

TABLE 25

Type of Labour in Herds of Different Sizes 1965/66

Size of herd Average number of cows	Percentage of herds		
	Family labour only	Paid and family labour	Paid labour only
less than 10·0	82	18	0
10·0–19·9	75	20	5
20·0–29·9	44	52	4
30·0–39·9	31	59	10
40·0–49·9	21	57	22
50·0–69·9	5	64	31
70·0–99·9	3	47	50
100·0 and over	0	24	76

Little family labour is at present used in herds of over 60 cows, but its importance in such herds can be expected to grow as family-manned herds of medium size expand. The family labour force operating these herds will no doubt prove to be capable of dealing with more cows per herd than at present. It is possible, however, that the increase in average herd size may lead to the additional use of paid labour in herds hitherto wholly or almost wholly operated by the farmer and his family.

Causes of variation in labour costs and hours

Labour is second only in importance to feed in the structure of milk production costs. It may therefore be useful to analyse the labour costs in order to find out the more successful ways of making economies.

The actual trend in the hours of labour in recent years is shown in Table 26 It can be estimated from earlier surveys, that the average labour requirement per cow in the late 1930s was about 170 hours annually and the average milk yield per cow about 640 gallons. Not much progress was made until after the war but since 1947 progress has been rapid. Milk yields have risen steadily. Hand milking has virtually disappeared except in a few small herds. Much attention has been directed to the design of suitable buildings and the working out of efficient routines of work. Interest has centred variously on cowshed layout, yard and parlour systems, cubicles for housing cows and bulk handling of milk. Undoubtedly many improvements have been made to existing buildings and it is a fair assumption that, with the concentration of milk production among fewer herds, many of the awkward and difficult buildings no longer house dairy cows.

The random sample results have been analysed to determine, as far as possible, the savings attributable to particular practices and types of equipment. Amoug other things it would be of interest to ascertain whether the potential savings of some of these have been obtained in practice. There are, however, considerable difficulties of classification and analysis. Neither buildings nor equipment fall naturally into distinct and clearly defined categories. There are numerous combinations of different types of housing, place of milking, and system of milking and within each there will be different sizes of herd, different levels of milk yield and differences in breed of cow, among other factors. These have to be brought into some sort of order before analysis can get very far. The procedure used has been to deal first with herd size and yield per cow and their relationship to labour hours and then to use the results to provide a basis for further analysis.

Before describing the results of these successive analyses in detail, a general comment can be made. The figures for the individual farms have been analysed in various ways in order to estimate the extent to which differences in herd size and other factors explain the variations in labour usage. It should be noted, however, that no combination of the factors taken into account in the various mathematical models explains more than about half the variation in labour hours between the individual herds. The remaining variation is no doubt due in part to differences in the age, training and quality of the labour as well as to differences in the suitability of buildings, and the distance that the milk has to be transported. None the less there is much that cannot be so easily explained and it appears that many of the farms with high labour costs could effect considerable economies by giving more attention to the general standard of their labour management.

Herd size

Table 26 shows the average time required per cow in herds of different sizes in the sample. Alongside the size-group averages is an analysis of the proportion of the herds in each group milked under different systems. These figures go some way to explaining the decline in the average hours required per cow with increasing size of herd. Parlour systems become dominant in herds of over 50 cows while most of the smaller herds are milked as well as housed in cowsheds. The questions remain whether the choice of system of milking is the dominant factor in obtaining labour economies in larger herds and whether any significant savings are to be discerned from increased size of herd within any particular milking system. They are discussed later in this section.

TABLE 26

Labour Hours per Cow and Place of Milking in Herds of Different Sizes

Herd size (cows)	Average labour hours per year	Percentage of herds with different places of milking			
		parlour	cowshed	other	All
6·0– 9·9	162	—	71	29	100
10·0–19·9	118	4	92	4	100
20·0–29·9	94	11	85	4	100
30·0–39·9	87	21	72	7	100
40·0–49·9	72	31	65	4	100
50·0–59·9	72	49	39	12	100
60·0–69·9	65	61	39	0	100
70·0–99·9	61	63	34	3	100
100 and over	62	62	14	24	100
All herds	88	16	76	8	100

Yield per cow

Another cause of variation is the level of milk yield per cow, although the amount of variation in labour requirements explained by this factor appeared to be small except with the highest yielding herds. It is probable that compensating factors are involved here. For example some of the lower yielding herds are on upland farms where climate and other factors are unfavourable. On such farms extra labour required for the longer period of housing and less modern buildings probably offset any saving of labour due to lower yields.

Housing and Milking Systems

Before an analysis could be made of the influence of housing or milking system it was necessary to establish a basis for grouping the herds. Initially 18 herds were excluded, either because they were hand-milked or because the herds were divided into more than one part run under different systems on the same holding. The remaining herds were then classified by three methods of housing, four places of milking and four methods of milking, giving no less than 48 possible combinations. The actual classification was as follows:

Method of Housing	(1) Cowshed (2) Yard (3) Out of doors
Place of Milking	(1) Cowshed (2) Milking Shed (3) Parlour (4) Bail
Method of Milking	(1) Bucket (2) In churn (3) Pipe line to churn (4) Pipe line to bulk tank

The data on labour hours for the individual herds were then standardized for herd-size and milk yield so that the effects of the other factors could be estimated. Analysis showed that there was no significant difference in the mean level of labour input between the three methods of housing, cowshed, yard and out-of-doors. This does not, of course, mean that in particular cases labour may not be saved by a change in housing. But it implies that the range in labour used was so great in all systems that the differences, if any, between types of housing, were obscured. On the other hand, place of milking appeared to have a significant influence on the labour hours required, and pipe-line milking systems showed savings over both in-churn and bucket milking.

These findings cleared the way for further analysis, based on six main systems which are described in Table 27. In defining these systems place of housing has been ignored and herds milked in a bail have been excluded because they were both few in number and diverse in their other characteristics.

TABLE 27

Simplified Classification of Dairying Systems

Dairying system	Place of milking	Method of milking
1	Cowshed or milking shed	Bucket or in-churn
2	,,	Pipeline to churn
3	,,	Pipeline to bulk tank
4	Parlour	Bucket or in-churn
5	,,	Pipeline to churn
6	,,	Pipeline to bulk tank

Differences in dairying system defined in this way explained more of the variation in labour requirements between herds than was explained by herd size and yield alone. But there remained, as one would expect, considerable variation between apparently similar herds, which must be attributed to factors which have not been taken into account. An important factor is undoubtedly the efficiency with which the whole routine of feeding and milking is carried out, in part due to the age, training and quality of the labour, but there are many others, such as the actual layout of the buildings, the types of feed given to the cows and the equipment available. Perhaps special mention should also be made of the clear evidence that many herds milked in ordinary cowsheds were being managed in ways which kept the labour requirement at a comparable level with that of more sophisticated systems. On the other hand, not all of the herds being operated with modern layouts and equipment were realizing the labour-saving that is possible, and perhaps necessary, to justify the capital expenditure incurred in their introduction.

The data on labour requirements for the individual herds have been used to estimate the relationship between dairying system, herd size and labour requirements. The results are shown in Table 28 in the form, for each system, of the estimated average requirements per cow for particular sizes of herd and the marginal requirements, that is, the additional labour hours needed, on average, when one cow is added to the herd.

TABLE 28

Average and Marginal Labour Requirements with Different Dairying Systems

Dairying system	Number of herds	Average labour requirements for different herd sizes					Marginal labour requirements
		20 cows	40 cows	60 cows	80 cows	100 cows	
		Man hours per cow					Man hours
1, 2 and 3*	287	103	87	81	78	77	70
4	45	86	70	65	62	60	54
5	39	84	67	62	59	58	51
6	31	73	57	52	49	48	41

*These systems have been combined because there were insufficient herds with systems 2 and 3 to permit separate estimates to be made for them. In an initial analysis there was some evidence that the two more sophisticated cowshed systems achieved labour economies relative to system 1.

These figures provide pointers to the ways in which labour economies can be obtained in dairying. The superiority of parlour milking over cowshed milking in terms of labour saving is not left in doubt; nor is the benefit to be gained from the installation of pipelines. The combination of all modern aids implied by system 6 was clearly advantageous in the 31 sample herds. The conclusion is clear also that increasing the scale of operations within each dairying system is an important source of further saving.

Size of one-man and two-men dairy herds.

Farmers considering the possibilities for the expansion of their dairy herds take a close interest in questions concerning the number of cows that can be handled by one man, or by two men. The estimates in Table 28 indicate the average size of a one-man dairy unit under the different milking systems. At the average levels of performance prevailing in 1965/66 it appears that one man handles about 26 cows under systems 1, 2 and 3, and 45 cows under system 6. With systems 1, 2 or 3 a two-man unit would be 62 cows and the numbers handled rise to 81 with system 4 and 106 cows for system 6. It must be stressed that, while these figures are reliable indicators of current average man/cow ratios, the planning of new or expanded dairy units is frequently likely to have as its aim the achievement of maximum use of the labour available. In such instances substantially higher-than-average labour economy can be expected.

Labour performance in milking routines.

A second feature of the results in Table 28 should also be borne in mind. The labour requirements on which they are based are those for all work directly devoted to the dairy herd, not for milking only. The number of cows a cowman can deal with when he is free of all duties other than milking is of course higher than the figures suggested above. The study of milking routines in March 1966, already referred to in Section II, showed the range of labour performance in the milking process alone in herds of different sizes in various places of milking. The average number of cows milked per worker was 29 in parlours and 12 in cowsheds. But these averages are depressed by the low figures for the smaller herds, particularly those of fewer than 20 cows. Such herds frequently form part of farm businesses which are too small, in relation to the fixed labour supply represented by the farmer and family workers, to call for the attainment of high rates of labour performance. The larger herds showed results more in line with current expectations. Parlour milking systems enabled herds of 60 to 70 cows to be milked by an average of 1·4 workers at a rate of 44 cows per worker, the figures rising, in herds of 100 and over, to 2·4 workers milking on average 57 cows each. Performance in cowshed milking systems was substantially lower, with an average, in herds of 60 cows or over, of just under 25 cows milked per worker.

V. BREEDING AND REPLACEMENT POLICY

Method of Service

Seventy-two per cent of all herds used artificial insemination only, 11 per cent used a bull only and the remaining 17 per cent used both methods. But as could be expected, there were considerable variations according to herd size. As herd size increased, A.I. was gradually replaced by natural service with 94 per cent of smallest herds and 10 per cent of the largest herds using A.I. only. Very few herds of less than 30 cows relied on natural service only. The advantages of both methods were sought in herds over 70 cows where over 60 per cent used both A.I. and their own bull. The greater use of natural service in the larger herds is probably partly explained by the lower costs per cow of maintaining a bull when it is spread over a greater number of cows.

Output from Calves

The herd income from calves depends on the calving rate, calf mortality and value at 4 days old. The estimated calving rate, (calves born in the year as a percentage of the number of cows at beginning of year) was the highest in herds under 10 cows at 102 per cent, but this figure is influenced by the fact that there was a reduction in herd size by the end of the year. The rate declined as herd size increased down to a level of 88 per cent in the 60–69·9 herd size group, but in herds over 70 cows, the rate increased again to nearly 97 per cent. The average rate for England and Wales was 93 per cent. This pattern could possibly be due to the greater difficulty of getting cows in calf in large herds. The better performance in this respect in herds over 70 cows may have been associated with their more common use of both natural service and A.I. The average calf mortality rate was 6·7 per cent of calves born, ranging from 5·1 per cent to 7·1 per cent but with no obvious pattern according to herd size. The average value of calves at 4 days was £10 7*s.* with a range from over £11 in small herds to under £9 for the larger herd sizes. There was, however, no indication of what might be the reasons for the smaller herds getting over £2 per head more for their calves than the larger herds.

Method of Herd Replacement

The distribution of herds according to their method of cow replacement for England and Wales as a whole showed that 17 per cent were 'flying herds' relying solely on bought-in replacements, 44 per cent bred all their replacements and 35 per cent used both methods. Four per cent of the herds made no replacements, which suggests that they were being run down. The method of herd replacement depends on several factors among which are the amount of land available, farmers' preferences, present quality of the herd, and economic considerations. It is not surprising, therefore, that there was no very clear pattern amongst different herd size groups. Herds under 20 cows did appear to opt for one method of replacement or the other rather than a combination of methods, with a rather stronger preference, compared with larger herds, for buying-in replacements rather than breeding their own. It is also noteworthy that as many as 18 per cent of herds under 10 cows obtained no replacements during the year. This is consistent with the tendency for the smaller herd to predominate among those going out of milk production.

Cost of Herd Replacement

The cost of herd replacement is taken to be the difference between the cost of replacements hrought in and proceeds from cow disposals plus or minus any decrease or increase in herd valuation between the beginning and the end of the year. Home-bred heifers entering the milking herd were valued at their estimated market value, exclusive of any special pedigree value. Purchased cows were valued at actual cost, and disposals were entered at the net price realized. The unit value of the cows in the herd was kept constant up to the time of their disposal, except where there was a major change in herd quality. The investigation showed that the average value of incoming cows and heifers was just over £90, ranging from £84 to £93 for different herd-size groups. The average cow disposal value was £58 with a range from £54 to £62. The average fall in value of each cow disposed of was therefore £32. This varied from £24 in herds under 20 cows to £40 in herds over 100 cows. Between herd sizes of 20 and 100 cows, however, there was no ohvious relationship between herd size and fall in cow value over their herd life. In herds under 20 cows, the cows were purchased more cheaply than average and sold at a lower than average price.

The difference between the incoming and outgoing value is not the only factor affecting the cost of herd replacement. The length of time for which the cow is retained in the herd is important and this is roughly indicated hy the proportion of the herd which was disposed of during the survey year. This proportion, 23 per cent in 1965/66 for England and Wales as a whole, suggests an average herd life of ahout 4½ years. Among the herd-size groups the proportion varied from just under 20 per cent to nearly 28 per cent, hut the variations are influenced hy a numher of factors among which an important one is the rate at which the herd-size is changing.

Changes in Size of Herd

All herd-size groups except the smallest showed an increase in average size between the beginning and end of the survey year, varying from 2 per cent to 6 per cent. The average size of herds under 10 cows declined hy ahout 7 per cent, prohahly reflecting the run-down of some herds which would eventually go out of production. It has heen noted earlier that ahout a fifth of these small herds brought in no replacements in the survey year; this group also had the highest disposal rate, 28 per cent. For England and Wales as a whole, herd-size increased by just over 3 per cent on average. The lowest average rate of increase was in the herds between 40 and 60 cows. This may indicate a point in the size-scale at which technical and management prohlems of operating larger herds become acute.

SUMMARY

1. This report summarizes the results of a national investigation into the economics of milk production carried out between April 1965 and March 1966. Information was obtained in respect of 434 dairy herds of various sizes throughout England and Wales.

2. A new feature of this survey compared with previous ones was the introduction of random sampling. This reduced the bias in selection and therefore enabled the sample to represent the national average economic and physical condition of the dairy industry in the survey year as nearly as possible. All the data shown are either raised totals or weighted averages reflecting the distribution of herds in size groups in the country as a whole. The sampling procedures are set out in a technical appendix. In addition to details of costs, returns and margins under different conditions of milk production, information was also collected about labour use, feeding patterns, milking systems and dairy buildings and equipment.

3. The results from this survey show that the total cost of milk production was £110 15*s.* 0*d.* per cow on average. The total returns were £139 16*s.* 0*d.* and the net margin was £29 1*s.* 0*d.* per cow. Average costs of production ranged from 29·1*d.* per gallon in the largest herd size groups to 44·7*d.* per gallon in the smallest, with a weighted average of 32·9*d.* per gallon. Of the total costs, feed accounted for nearly 52 per cent and labour 23 per cent.

4. Because previous surveys were carried out on a non-random sample, comparisons with previous years must be treated with caution. The results of the 1961/62 survey used in this report have, however, been adjusted to the herd size distribution of the national dairy herd in that year. These two surveys show that by 1965/66 average costs had gone up by 3½*d.* per gallon, and returns by 5¼*d.* per gallon, to give an increase in average net margin of 1¾*d.* per gallon, though, because of sample bias in the earlier sample, this increase in net margin may understate the improvement during the four years.

5. Net margin per cow showed appreciable variation between different herd size groups with the largest herds attaining a higher net margin than the smallest herds. This was caused mainly by the higher labour cost in the smaller herds. Family income per cow did not show the same variation because of the much higher proportion of unpaid family labour used in the smaller herds.

6. The total quantity of nutrients fed to dairy cows cannot be accurately estimated. The quantity of concentrates fed, however, in relation to milk produced implies a strikingly small amount of production to be credited to grazing and bulk fodders. The report concludes that in general the tendency is to over-feed concentrates and to under utilize grass and other fodders. Analyses are set out to demonstrate the underlying causes of this situation.

7. The influence of herd size on the costs and efficiency of feeding the herd was not very great and less than might be expected. Some small saving does, however, stem from the ability of larger farms to grow more cereals for feeding dairy cows.

8. On average, higher yields obtained from high levels of concentrate use did not lead to higher margins over feed. There was evidence of high summer concentrate feeding not associated with seasonality of production. A major

underlying factor was thought to be that the milk producing potential of cows did not in general match the feed fed: but where the cow potential was good, its exploitation by high levels of concentrate feeding was shown to be profitable.

9. The substitution of bulk fodder for concentrates in winter feeding was shown to be unprofitable.

10. Dairying is essentially a land using enterprise. Since the availability of land is a limiting factor on most farms, the intensity of its use in feeding the dairy herd is critical to the success of the enterprise. The survey showed that a high summer stocking rate led to higher margins per acre for all combinations and levels of concentrate and bulk feeding. It was chiefly brought about by skill in management in obtaining full utilization of a high level of grassland production. High stocking levels produced estimated rates of Utilized Starch Equivalent per acre well in excess of the average.

11. The report shows that over the years the average labour requirement per cow has been reduced in all herd-size groups and that an increasing proportion of this requirement has been supplied, in all but the larger herds, by family labour. Large herds still rely mainly on hired labour.

12. The labour-saving associated with large herds was obtained both by adopting parlour milking systems and from economies of scale alone. The numbers of cows milked per worker were substantially greater in parlour systems than in cowshed milking.

13. Estimates of the size of herd that can be handled by one man at average levels of performance reflect the economies obtainable in parlour milking systems. Average labour performance is depressed by the situation in small herds where the available labour is not matched by a sufficient number of cows to enable it to be fully utilized.

A detailed description of the methods of analysis used in this report and an appraisal of their effectiveness will be published in due course.

Note:—Detailed tabulations of the results of this investigation for the period April, 1965 to March, 1966 will be made available to research workers on application to the Milk Marketing Board or the Economics Division of the Ministry of Agriculture, Fisheries and Food.

APPENDIX I

SAMPLE SELECTION AND METHODS OF CALCULATION

The Sampling Frame and Sampling Fractions

The September 1964 one-third Census formed the frame from which the random sample for the 1965/66 Milk Costs Investigation was drawn. All holdings with dairy herds of 6 or more cows at that date, provided they were not created after June 1963, qualified for selection, but only those with an average number of cows above this level in 1965/66 were included in the final sample to be analysed.

The random sample chosen was stratified by herd size, and the sampling was conducted in such a way as to reflect the distribution of herds by geographical area and farm size.

The stratification, with variable sampling fractions for various herd size strata, represented an attempt to minimize the expected sampling error of total cost per gallon. This required the sampling fraction of a particular stratum to be proportional to (a) the within-stratum variation in cost per gallon and (b) the volume of output per herd in the stratum. The second factor was by far the more important, with the result that the sampling fractions varied from 1 in 120 for herds with 6–9 cows to 1 in 18 for herds of 70 cows and over. In detail the sampling fractions in each herd size group were as follows:

6– 9 dairy cows	1 in 120
10–19 dairy cows	1 in 90
20–29 dairy cows	1 in 69
30–49 dairy cows	1 in 51
50–69 dairy cows	1 in 30
70 and over dairy cows	1 in 18

Raising Procedure

In raising the results of the sample to give aggregates for England and Wales of, e.g., total sales, total cow numbers, each herd's results were multiplied by a raising factor derived from the number of herds of that size in the sample and in the whole population. Although the September 1964 Census provided the frame for the selection of the sample, the raising factors were calculated by reference to the June 1965 Census.

The table on page 49 shows the derivation of these raising factors.

Each herd's results were raised by the appropriate factor, and in tables involving classifications other than by herd size the means in each cell were weighted according to the herd size stratum from which each herd was drawn.

Calculation of Averages

As in past investigations, all averages in terms of £ per cow, *d.* per gallon, hours per cow, cwt per cow, etc., have been calculated for all herds in a cell taken as a whole. In other words, they have not been taken from averages of individual herd averages. This method gives equal weighting to each cow,

	Herd size (cows)						
	6–9	10–19	20–29	30–49	50–69	70 & over	Total
Number of herds in population (June 1965 Census)*	10,709	31,751	22,961	19,960	6,713	4,209	96,303
Number of herds in sample	17	92	81	121	64	59	434
Raising factor	629·9	345·1	283·5	165·0	104·9	71·3	—

*These are the results of a raised one-third sample, so they do not correspond exactly with the final Census results.

gallon, etc. in the group of herds, whereas the 'average of herd averages' method would exaggerate the influence of the cows in the smaller herds. In the same way, the means for the sample as a whole have been calculated from the sum of the raised totals for each size group. Such means are, therefore, weighted averages adjusted to the average size of herd in the population.

In the tables involving classifications other than by herd size, e.g., average yields etc., by farm size, the means in each cell were weighted according to the herd size stratum from which each herd was drawn.

Distributions of Herds

The distributions of the Raised Sample, given in Tables 5, 6 and 8, according to farm size, place of milking and herd size are estimates of the corresponding distributions of all herds in the population. Statements in the text of the report about the proportion of herds exhibiting certain characteristics, e.g., reliance on A.I. or on bought-in replacements, are also based on the Raised sample results. The distributions of the 434 sample herds, on the other hand, shown in other tables according to stocking rates, level of concentrates or fodder dry matter fed, seasonality and milking system, are not estimates of this kind. They are included as an indication of the relative reliability of the average results shown in each cell.

APPENDIX II

Names and Addresses of Provincial Agricultural Economists

PROVINCE	
Northern (NEWCASTLE) Cumberland Westmorland Durham Northumberland	Prof. J. Ashton, M.A., M.S.(Cornell), B.Litt., Department of Agricultural Economics, The University of Newcastle-upon-Tyne, Newcastle-upon-Tyne, 1.
North Eastern (LEEDS) Yorkshire	W. H. Long, Esq., M.A. Agricultural Economics Section, 40, University Road, Leeds, 2.
East Midland (NOTTINGHAM) Derby Leicester Lincoln (Kesteven) Lincoln (Lindsey) Northampton Nottingham Rutland	Professor D. K. Britton, M.A., B.Sc., (Econ.) Agricultural Economics Department, Nottingham University School of Agriculture, St. Michael's House, Sutton Bonington, Loughborough, Leics.
Eastern (CAMBRIDGE) Bedford Cambridge Essex Hertford Huntingdon Isle of Ely Lincoln (Holland) Norfolk Soke of Peterborough Suffolk	F. G. Sturrock, Esq., M.A., B.Sc., School of Agriculture, University of Cambridge, Cambridge.
South Eastern (WYE) Kent Surrey Sussex, East Sussex, West	Professor G. P. Wibberley, B.Sc., Ph.D., M.S., Wye College, University of London, Nr. Ashford, Kent.

Southern (READING)

Berkshire
Buckingham
Hampshire
Isle of White
Middlesex
Oxford.

Professor R. H. Tuck, M.A.(Oxon),
Department of Agricultural Economics,
University of Reading,
7, Redlands Road,
Reading, Berks.

Western (BRISTOL)

Gloucester
Hereford
Somerset
Warwick
Wiltshire
Worcester

S. R. Wragg, Esq., M.A.
Agricultural Economics Department,
University of Bristol,
79, Woodland Road,
Bristol, 8.

South Western (EXETER)

Cornwall & Scilly Isles
Devon
Dorset

S. T. Morris, Esq., M.Sc.,
Department of Economics (Agricultural Economics),
University of Exeter,
1, Courtenay Park,
Newton Abbot, Devon.

North Western (MANCHESTER)

Cheshire
Lancashire
Shropshire
Stafford

Professor W. J. Thomas, M.Sc.,
Agricultural Economics Department,
The University,
Manchester, 13.

Wales (ABERYSTWYTH)

Professor H. T. Williams, B.A.,
Department of Agricultural Economics,
University College of Wales,
Institute of Rural Science,
Penglais, Aberystwyth, Cards.

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Essential to good grassland management—heavy stocking and an extended grazing season

March (*Photo: C. D. Millington, Welshpool*)

October (*Photo: I.C.I.*)

PLATE I

Accurate feeding (*Photo: Milk Marketing Board*)

Milk recording (*Photo: Milk Marketing Board*)

Milk recording facilities, accurate feeding and modern equipment, such as calibrated jars and flow meters, reduce the labour involved

Feed accounts for over half of the cost of producing a gallon of milk, so accuracy in dispensing concentrates is essential

PLATE II

Modern parlour layout (*Photo: Cowderoy and Moss, Ltd.*)

Artificial insemination (*Photo: Milk Marketing Board*)

Records of breeding data help control calving interval and yield per annum

Modern two-level parlours enable one man to efficiently milk a large herd and thus reduce labour overheads

PLATE III

Of. 5100.2.052

Costs and Efficiency in Milk Production 1965/66

CORRECTION

Page 7. Penultimate line. £4 9s. per acre *should read* £4 18s. per acre.

Page 18. Table 13: 100 cows and over. Against total costs *read* 103.50 *and not* 105.50.

Page 19. Fifth paragraph. *Delete* last sentence.
Last line on page. *Amend* Section II *to read* Section V.

Page 32. " Utilized Starch Equivalent ", first paragraph penultimate line. *Delete* semi-colon after " sample results " and *insert* comma.

Page 36. Footnote: Reference to 1964/65 milk prices *should read* 1965/66.

Ministry of Agriculture, Fisheries and Food
November 1967

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